MECHANICAL ENGINEERING

Diesel Engines Furnish the Power

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DEPARTMENTAL

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What It's All About

WRITING for the April, 1930, issue of MECHANICAL ENGINEERING at a time when it was impossible to foresee the full significance of the major economic adjustments that would be necessary following the stock-market debacle of 1929, Mr. Charles Piez, then President of the A.S.M.E., said:

"Technologically, the future is secure. We have learned the art of applying science to useful ends. What we still lack is that greater wisdom to wipe out the plague spots, to bring about an orderliness in the control of the vast forces we unloose so that we may have progress without the waste in human and other material which has marred many of our past efforts. The problems involved are largely outside of engineering in its narrow sense—they are humanitarian, economic, and political problems. But before engineers can hope to realize the position that is rightfully theirs, they must arouse their consciences and recognize that they are members of society and not merely technicians."

With 1931 drawing to its close, the character of the economic changes forced upon nations all over the world, their seriousness, and their political and social consequences have become more apparent and tend to justify Mr. Piez's statement. Evidence of this is to be found in the pages of this issue of MECHANICAL ENGINEERING.

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THROUGHOUT the review of the Progress Reports of the A.S.M.E. Professional Divisions, which covers a majority of the following pages, the forward surge of technology is a hopeful and vital theme. A secondary theme of the impress of economic influences and their social consequences persists also, more boldly stressed in some parts than in others, but naturally more audible this year than usual. It is the interaction of these two themes upon each other that justifies the broad policy which MECHANICAL ENGINEERING adopts toward the innumerable problems that confront the profession and its members.

WHILE the optimistic remind us that depressions always end, the stern finger of fact is pointing to the inevitably cyclical character of economic history, and the sceptic is moved to ask, "If prosperity comes, can depression be far behind?" Wise men and serious students will therefore make use of their present discomfort to guard against its repetition.

At the present writing it seems obvious that questions of technological advance are subordinate to those which have economic, social, and political direction. The Progress Reports indicate that there is little need to worry about the creations of applied science that serve man so well when he allows them to do so. From these reports, and from the report on 1930 earnings of mechanical engineers, it is obvious that most engineers have obligations, responsibilities, and opportunities for service outside of the narrowly technical field which has to do with the direction and control of materials and forces. This fact brings all engineers together as professional men, and provides the purpose and inspiration for the editorial policy under which MECHANICAL ENGINEERING is being developed. That it shall provide a proper balance between technology and wisdom to apply it successfully is the hope of those who direct this policy.

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THE cover picture, which shows a modern United States Submarine, is used in connection with Commander Gibson's article on "United States Navy Diesel-Engine Requirements." In view of the discussion of this subject that has taken place in Congress and in the newspapers, Commander Gibson's point of view is both interesting and timely.

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AN interesting high-pressure boiler designed for research and development work with power-plant equipment has been installed at the Yarnall-Waring Co., Chestnut Hill, Philadelphia. It is described in the present issue of MECHANICAL ENGINEERING.

MECHANICAL ENGINEERING

Volume 53 December, 1931 No. 12

U. S. Navy Diesel-Engine Requirements

Problems Encountered and Experience Gained in the Powering of Submarines—Light Weight and High Speed Essential Requirements for Diesel Engines for Naval Use

By HOLBROOK GIBSON,[1] WASHINGTON, D. C.

THE United States Navy has confined most of its Diesel-engine activities to the submarine, which by its nature makes it essential that the vessel be driven by internal-combustion engines.

Prior to 1912, the few submarines that were then in service—vessels of limited cruising radius, small armament and small displacement—were propelled by gasoline engines. At that time the necessity for larger boats was realized, and with it the necessity for an increased size of power plant. In addition there was always a great element of danger in handling gasoline in large quantities to propel the vessel, and the consumption of fuel was great.

In 1912 the submarines of the E-1 and E-2 class were completed and placed in commission with the first Diesel engines used by our Navy for propelling a war vessel.

The experience gained with these engines convinced the Navy Department that the Diesel motor was the only satisfactory one for submarine surface propulsion and for generating power to charge storage batteries. These engines were of the four-cycle type.

Following the E-class, a few vessels of the F-class were built; these were equipped with the same kind of an engine, but having six cylinders instead of four, as the vessels were of somewhat larger displacement.

The next series of boats were three H-class submarines, and the engines, which were built in the United States under a license agreement with a foreign manufacturer, were two-cycle, single-acting, step-piston engines. The results obtained were better than those from the first four-cycle Diesel engines, but, unfortunately, for various reasons this type was not considered to be very satisfactory for submarine use, and was discontinued with the completion of the L-class submarines.

At about this time the World War focused attention on the submarine. On account of the unusual performance of the German submarines, there was much speculation as to the type of engine they employed. The majority of naval officers, and others interested in Diesel engines generally, believed that the German submarines undoubtedly were using Krupp two-cycle engines. Upon the conclusion of the war, however, it was found that practically all the vessels of the German Submarine Service, both large and small, were equipped with Diesel engines of the four-cycle type.

[1] Commander, U. S. Navy Bureau of Engineering, Navy Department. Commander Gibson was graduated from the U. S. Naval Academy in 1909. He joined the Submarine Service in 1912, and was inspector of machinery at the plant of the New London Ship and Engine Company, New London, Conn., during the World War. At the close of the war he became Submarine Officer on the Staff of Admiral W. S. Sims, U. S. N., in London. He returned to the United States after the armistice in command of a German submarine, and was in charge of dismantling and testing machinery from such vessels at the Navy Yard, Philadelphia, in 1919. Since 1924, with the exception of the years 1927–1929, he has been on duty in the Bureau of Engineering, Navy Department, Washington, D. C., in charge of design of submarine machinery and internal-combustion engines.

Contributed by the Oil and Gas Power Division for presentation at the Annual Meeting, New York, N. Y., Nov. 30 to Dec. 4, 1931, of The American Society of Mechanical Engineers. All papers are subject to revision. Abridged.

Problem Now Faced by the Navy

Since the signing of the London Treaty, the Navy has been confronted with an entirely new problem. We have a fixed tonnage displacement by terms of the treaty, and from that the Navy must develop as many efficient fighting units as is possible. Obviously, in submarines, this means engines lighter in weight, more compact, and of more horsepower per unit of weight than have ever been obtained before. These, briefly, are the Navy's requirements for Diesel engines.

Shortly after the World War the Bureau became convinced that the four-cycle Diesel engine found in the majority of the German submarines was a very highly developed product and apparently had been designed especially for submarine use by the German Government. This engine was made in various sizes and powers, and had but about half the weight of a contemporary Diesel engine for submarine use as manufactured by the United States builders. It was exceedingly reliable, maneuvered readily on air, both ahead and astern, had a very fine control over a wide range of speeds, and, in addition, was economical in fuel and lubricating oil. The most striking feature of the design was the very intricate light-weight steel castings used in the construction of the bedplate and cylinder housings, and these accounted to a very large extent for the reduction in weight per unit of horsepower.

The first efforts to duplicate these engines were made by the Navy Yard, New York, and great difficulty was experienced in obtaining satisfactory steel castings. Several American manufacturers endeavored to make them for the Navy, but finally asked to be released from their contracts, on the ground that it was impossible to supply them as a commercial proposition. Rather than abandon the attempt to manufacture or duplicate this type of engine, the Bureau decided to make the steel castings in the Government yards. Eventually, sufficiently satisfactory castings were delivered to the Navy Yard, New York, and several of this type of submarine engine were manufactured. The latest engines built at that yard employ very satisfactory castings which were made by the Naval Gun Factory, Washington, D. C.

Fundamental Requirements in Diesel Engines for Submarine Use

With this requirement of a comparatively light-weight Diesel engine, there are three fundamentals which are also of paramount importance. The first is reliability, the second, accessibility, and the third, simplicity. To obtain these three requirements three other factors enter into the problem—design, material, and personnel.

There was a time in the Navy when the Bureau of Engineering did not know very definitely whether or not a cause for a certain trouble in a Diesel engine was due to design, material, or personnel. It was a very difficult matter to determine, and the usual way out of the difficulty was to supply spare parts of machinery. The assumption was that it was the nature of the Diesel engine to break down and require an abnormal number of spare parts and amount of upkeep to maintain it so that it could perform as designed. The material was procured in the customary manner on bids from various manufacturers and navy yards.

As the cost of supplies kept mounting higher, more thought was given to the problem and a decided change was made in the procurement of Diesel-engine parts. The Bureau decided that all material necessary for submarine machinery should be manufactured or obtained by one Government yard, so that it could be properly supervised and inspected to see that it was made according to specifications. The Bureau felt that if this one element of doubt could be eliminated from the problem it would then be possible to analyze casualties and to differentiate between the factors design and personnel. The outcome was that the Bureau concentrated all Diesel manufacturing work at the Navy Yard, New York, which yard had a nucleus of men and officers who were familiar with the Diesel engine. The Bureau insisted emphatically that all work turned out at the Navy Yard, New York, should be as nearly perfect as it was possible to make it. There was considerable opposition from the New York Yard at first to the effect that the Bureau's requirements were unnecessary and unreasonable, and that it was wasting money and rejecting perfectly good material. Undoubtedly much material which was usable was scrapped, but, in the long run, it is believed that the policy was sound and has been very beneficial. The Bureau has consistently required and still does require the Navy Yard, New York, to turn out submarine material in exact accordance with plans. This stamped and dated with their marks. It can thus be readily identified in case it does fail in service or is of an inferior quality, or is not made in exact accordance with the specified dimensions.

In addition to the foregoing exacting requirements, either the piece that fails in service or a sample of the material, must be forwarded to the Engineering Experiment Station, Annapolis, Md., for investigation. A report of the investigation is sent to the Bureau of Engineering, from which the Bureau is able to determine whether the material was defective, whether its characteristics have been changed by fatigue, or whether it is unsuitable for the purpose for which it has been used. The Bureau is also kept informed by the Station of the progress in metallurgy. New materials, such as special steels, are being investigated for the purpose of improving the performance of Diesel-engine parts which are subjected to heat stresses and corrosive action.

This policy of carefully supervising the procurement of Diesel-engine material gradually changed the entire situation, and the Forces Afloat found it more difficult to lay the blame for an unreliable Diesel engine on faulty material. Also, the manufacturing yard, during their close inspection, found many minor errors in working drawings which prior to this time had escaped notice.

At the same time, the operating personnel were gaining valuable experience, and eventually both officers and enlisted men were required to attend the Submarine School at New London, Conn., for a course of instruction before serving on the submarines. In the case of officers the course is six months. Also each submarine now has assigned to it an engineer officer who has had a postgraduate course in Diesel engineering, whose primary duties are the care and maintenance of the machinery. And a recent addition is the Division Engineer Officer, whose sole duties are to see that the upkeep and maintenance of the submarines of a unit are uniform and in accordance with existing instructions and orders.

The result of this gradual progress or development has been that the Bureau is now able to determine fairly definitely the cause of a casualty on a Diesel engine. Finally, from an analysis of the facts embodied in reports of casualties, it has been compelled to make many changes from the original design of our older submarine engines, and these engines are operating today because of these changes.

In other designs of engines the difficulties could not be corrected as they were too fundamental, and the result was that the engines were eventually discarded and the vessels repowered. Even now, the older-type engines, in spite of all the modifications that have been made, cannot in any sense of the word be considered as satisfactory or suitable for the requirements of the present day.

Vibration Problems Encountered

As soon as the Diesel-engine units became larger and powers and speeds increased, the Bureau was confronted with the very serious problem of critical speeds due to synchronous torsional vibration. Very little was known about this subject ten years ago, and the engines, while making splendid performances on the builder's test bench, would nevertheless fail completely after installation in a submarine.

This question assumed very serious proportions shortly after the close of the World War, and it became necessary for the Bureau to engage scientists to determine the cause of the trouble and to outline corrective measures. After expending large sums in making such changes as were possible, the synchronous torsional vibration in certain classes of submarines was definitely determined and the prohibited operating ranges marked. The engines were built and installed, but the best that could be obtained was a machinery arrangement that had very limited bands of clear operation; in some cases the prohibited range fell at the top of the operating range so that it was impossible to operate the machinery at full power. To overcome this difficulty in future designs, personnel at the New York Yard were instructed in the methods for calculating critical speeds from the preliminary design of the machinery. Also, personnel in the Bureau were trained in the same line of work. The result has been that the Navy has developed a number of specialists who, it is believed, are without equal anywhere in the United States. These specially trained men have been called by commercial firms to investigate similar problems, and in some cases have been attracted to more remunerative positions with well-known American Diesel firms.

Another very important problem, which was entirely overlooked in the pioneer days, is the question of the mean effective pressure in the working cylinders. It has been learned by experience that the mean effective pressure in the cylinders of a Diesel engine does vary considerably owing to causes beyond the control of the captain of the ship, such as bad weather, foul bottom, bent propeller blades, increased draft, head winds, etc. The Bureau has taken all these factors into account, and, particularly in the Submarine Service, the mean effective pressure can be readily determined for the conditions under which the machinery must be operated. This is done by taking what is called a "spot" with the electric motors of the ship at certain speeds of revolution and determining the electric power, from which calculations are made to see whether or not the operation of an engine at a certain speed and power will cause the mean effective pressure to be exceeded. This alone has done much to increase the reliability of Diesel machinery.

But, unfortunately, the combination of critical speeds and excessive mean effective pressures very frequently results in a condition which makes the available free operating range of the engine very limited, indeed. The Navy Department now has in operation a plan whereby every submarine is docked about every eight or nine months, solely for the purpose of cleaning the bottom, so that this condition can be corrected.

Accessibility of Prime Importance

The question of accessibility of Diesel engines, particularly for submarines, is one of paramount importance. In the engine room of a submarine, space around and above the engine is at a premium. Frequently it is a case of picking a small man to squeeze into a restricted space to make some adjustment. Also the space overhead is very limited in height, and usually congested with miscellaneous gear. Accessibility of the engine itself is a very important matter, and, from a military standpoint, is fundamental. Repairs must be quickly and easily made, and adjustments accomplished in a minimum of time.

The question of simplicity of design is closely associated with that of accessibility. An engine that is simply designed in its major parts is usually accessible, but not always. What is required are parts that in themselves are simple in construction and whose number can be kept to a minimum, and that can be used as far as possible on engines of opposite hands, thus eliminating rights and lefts. The task of procuring and carrying spare parts for machinery of vessels of the United States Navy is a very real problem in peace time, and in time of war is very serious. It can thus be readily appreciated that it is an absolute necessity

that engines be designed so that the parts can be used for either a right-hand or left-hand engine whenever it is possible. It is acknowledged that this requirement cannot be completely met in all cases, but much can be accomplished toward this end in the early stages of preliminary design. In addition to making parts interchangeable, it is also necessary that the functions of the various elements of the engine be accomplished with as few parts as possible, thus eliminating complication and the attendant increased liability of breakdown.

It is thus seen that the Diesel-engine problem in a submarine is at best a very difficult one, and, while an engine may be perfectly satisfactory and extremely reliable for commercial use on land or for marine use, it is possible for it to be a complete failure when installed in a submarine, due to the entirely different conditions under which it has to operate. This is not the fault of the Diesel engine but is a question of the application of the Diesel-engine design.

Along with the reduction of weight of Diesel engines, the Bureau has considered the practicability of using supercharging. At the present time, however, it is considered more desirable for the Navy's purposes to utilize the weight and space which would be required for a supercharging system for an additional working cylinder or larger cylinders, as it is believed that the simplicity and additional power gained thereby will very nearly compensate for the extra power that can be obtained by using the supercharging system.

Until recently, all Diesel engines used in the United States Navy have employed the spray-air system for the injection of fuel. It is realized that great progress has been made in the so-called solid-injection system, but the Bureau was very reluctant to discard the spray-air system despite its many disadvantages, principally because this system gives a very fine and flexible control of the Diesel and clear exhaust at all speeds, and also because of the fact that compressed air is extensively used for many purposes on submarines, and the compressor on the engine is an economical source of such air supply. However, the Bureau now believes that the solid-injection system has been perfected to a point where good combustion can be obtained at all speeds and powers. The next submarine to be constructed will have engines of the solid-injection type. By eliminating the air compressor, more effective horsepower with the same weight and space can be developed and delivered to the propeller. Also, one of the most unreliable features of the Diesel engines in the past, namely, the air compressor, can be eliminated. Many a Diesel engine has been considered unreliable primarily due to air-compressor troubles, while the Diesel engine itself had not suffered a casualty.

Most of the foregoing remarks so far have been confined to the submarine engine, which at the present time is the most important Diesel-engine question which the Bureau has to solve. The Bureau, however, is studying the problem of Dieselization of various types of surface ships.

Training of Personnel

In an effort to prepare specifications for the types of Diesel engines which must be built to meet the Navy's requirements, the Bureau has endeavored to obtain accurate information regarding the progress of the Diesel-engine art from every available source. Officers trained in Diesel engineering have been sent abroad as assistant naval attachés, and have traveled extensively and visited the plants of practically all foreign Diesel-engine manufacturers. From this source, the Bureau has been able to obtain very valuable and complete information regarding the progress of the Diesel-engine art in Europe. Much information that is not available to the layman has been furnished confidentially to the Bureau of Engineering. At the same time, the Bureau has kept in touch with the Diesel-engine manufacturers of the United States.

It is fully realized that it is unreasonable and unfair to expect Diesel manufacturers to build special engines suited to the Navy's particular requirements without proper and sufficient compensation, as we all know that Diesel experimentation is very costly both in time and in money.

Diesels for Surface Ships

Undoubtedly the type of engine that will be employed for surface ships, which requires large amounts of power, will be the double-acting two-cycle type. The necessary auxiliaries, such as the blower and electric power for pumps, of course, will be driven by a separate unit. It is believed that this type of engine is reliable as it has been highly developed in the past few years, it is extremely light, well balanced, and simple, and can be made in small or large units; and in view of these characteristics, will undoubtedly lend itself extremely well to Diesel-electric propulsion. By using a multiplicity of units, the power required can be readily varied in an efficient manner.

As a typical example, consider a vessel with maximum speed of around 21 knots and 6000 hp. If such a ship were propelled by either a single-screw direct drive or a twin screw, it is immediately apparent that to drive the vessel efficiently at all powers would be almost an impossibility. In the case of a single-screw ship, the main engine would have to be operated at very low powers in a very inefficient manner. In the case of a twin-screw ship of the same horsepower, either both engines would have to be operated at very low powers, with high fuel consumption and low mechanical efficiency, or one engine would have to be shut down and only the other operated, still an inefficient method. Operating a twin-screw ship with only one engine is very awkward, as it means that, in order to keep the ship on a given course, a certain amount of rudder will have to be constantly carried. This is very undesirable and puts considerable drag on the ship, with increased fuel consumption. Hence it would seem much better if this power could be divided up into a multiplicity of separate Diesel-electric units, for example, three or four, and the main shafts be driven electrically. This

arrangement would permit both screws to be operated at all times and the power utilized from the engines as required. Of course, the argument is immediately presented that the Diesel-electric drive arrangement also has very decided disadvantages. High-speed motors necessary to drive the ship would drive through reduction gears, and such an installation would immediately increase the weight of the entire machinery installation to that of an efficient steam plant, thus nullifying the saving in weight in the design of the Diesel engine itself. However, this is not entirely true, and the Bureau is of the opinion that in many cases the tendency will be toward Diesel-electric drive. There are many advantages in favor of such a machinery arrangement, such as wide range of control, efficient operation of individual units, efficient propeller speeds, multiplicity of units—which means increased reliability in case of breakdown of one unit, elimination to a large extent of shafting troubles, critical speeds due to synchronous torsional vibration, and heavy engine parts, and the prevention of overloading machinery with the resulting high mean effective pressure due to foul bottom, bad weather, or damaged propellers, that more than counterbalance the disadvantage of the increased weight due to reduction gears and high-speed electric motors.

It was felt that, in order to determine with the least delay what the Navy really could obtain in Diesel engines to meet its particular and special requirements, it would be necessary to obtain money from Congress for experimental work. It did not seem to the Bureau reasonable or fair to require a Diesel-engine manufacturer to build an engine for the Navy from specifications when it was not known definitely whether such specifications could be met. In other words, the Bureau did not want to ask for the impossible. To this end it was decided to purchase a few typical engines representing what was considered to be the best and most advanced European practice and determine actually the performance of these engines, and then prepare specifications and request American manufacturers to equal or better that performance.

At the last session of Congress, $3,000,000 was requested for this purpose, but this appropriation was not passed.

The Bureau was criticized severely from certain sources for even attempting to obtain any sample engines whatsoever from Europe. Some felt that all the money should be spent in development in the United States. There was quite a controversy over the matter in the newspapers and in Congress, as apparently some of the American Diesel-engine manufacturers felt that the Navy was discriminating against them. Needless to say, this was not the case nor the intention. The Bureau was merely endeavoring to obtain information as to what the Diesel engine could do.

The idea that cropped up during the controversy that the Navy was going to buy all of its Diesel engines in Europe, is incorrect. The Bureau has no intention of following such a policy. However, it may be forced to continue to build engines at the Navy Yard, New York, as it has done for several years in the past, if it cannot obtain the kind it requires from American manufacturers.

The Bureau feels, however, that this will not be necessary as the development of the Diesel engine along lines similar to the requirements of the Navy for its submarines is taking place today in the commercial field. This is particularly true in the development of the Diesel locomotive, the requirements of which approach very closely those of a Diesel engine for the Submarine Service. It is well known that this application of the Diesel engine is progressing steadily and surely, and that great strides are being made in the development of the locomotive type of engine.

Diesels for Naval Use Must Be of Light-Weight, High-Speed Design

From this survey of the Diesel-engine field both at home and abroad, the Bureau has reached the conclusion that the modern Diesel engine for naval use must be of the light-weight, high-speed design. Whether of the four-cycle type or the two will depend upon the particular application. To be more specific, and considering the development as it stands at the present time, the submarine engine will be a four-cycle, single-acting one for power up to about 2000 hp. per shaft for the direct-driven installation. For higher powers in the submarine, undoubtedly the light-weight double-acting two-cycle engine will be necessary. Also, both the four-cycle and two-cycle double-acting, light-weight and very high-speed engines will be seriously considered for submarine Diesel-electric drive, with three or four identical Diesel generators.

For all types of surface ships from the tanker to the light cruiser, the trend is unmistakably toward the double-acting two-cycle type of Diesel, the weight and speed depending upon the power required and the weight and space limitations placed upon the machinery requirements. The manner of absorbing the effective horsepower will vary according to conditions from the conventional direct-drive moderate-speed Diesel to the higher-speed engine with gear drive. Multiple units of higher speed will drive through clutches and reduction gears. Finally, there is the all-electric drive with a multiplicity of Diesel generator units of the very light-weight high-speed type.

Unfortunately, the Bureau has had very little first-hand experience with high-speed Diesel engines both of the four- and two-cycle types, and it desires to obtain both in this country and abroad typical examples of this trend in the art, and test them thoroughly to determine whether or not the attractive features of these designs can meet the requirements of the Naval Service. In fulfilment of this plan, the Bureau hopes that it will be permitted to present to Congress again at the coming session a bill for the necessary legislation to provide for the development of the Diesel engine to meet the Navy's special requirements.

1930 Earnings of Mechanical Engineers—III

Clippings From the Chart Book of the A.S.M.E. Committee on the Economic Status of Mechanical Engineers

IV Earnings in the Principal Industries

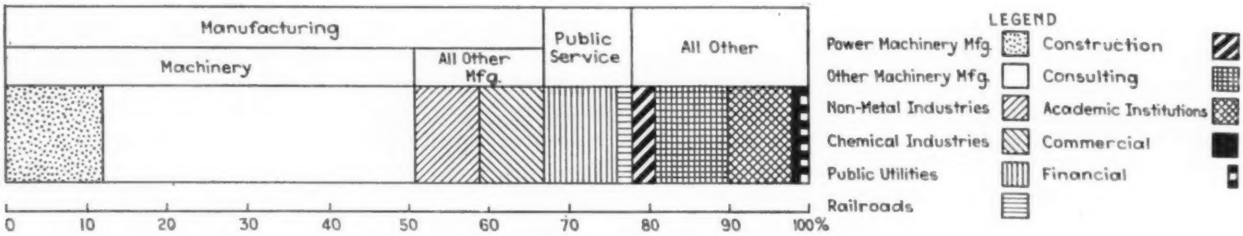


Fig. 1 Distribution of Mechanical Engineers Among the Principal Industries

Notice the concentration of 67 per cent of mechanical engineers in some form of manufacturing, and the still more striking concentration of 51 per cent in the several machine-manufacturing industries. Here, and throughout this report, figures as to distribution of engineers are based upon the distribution of members replying to the questionnaire.

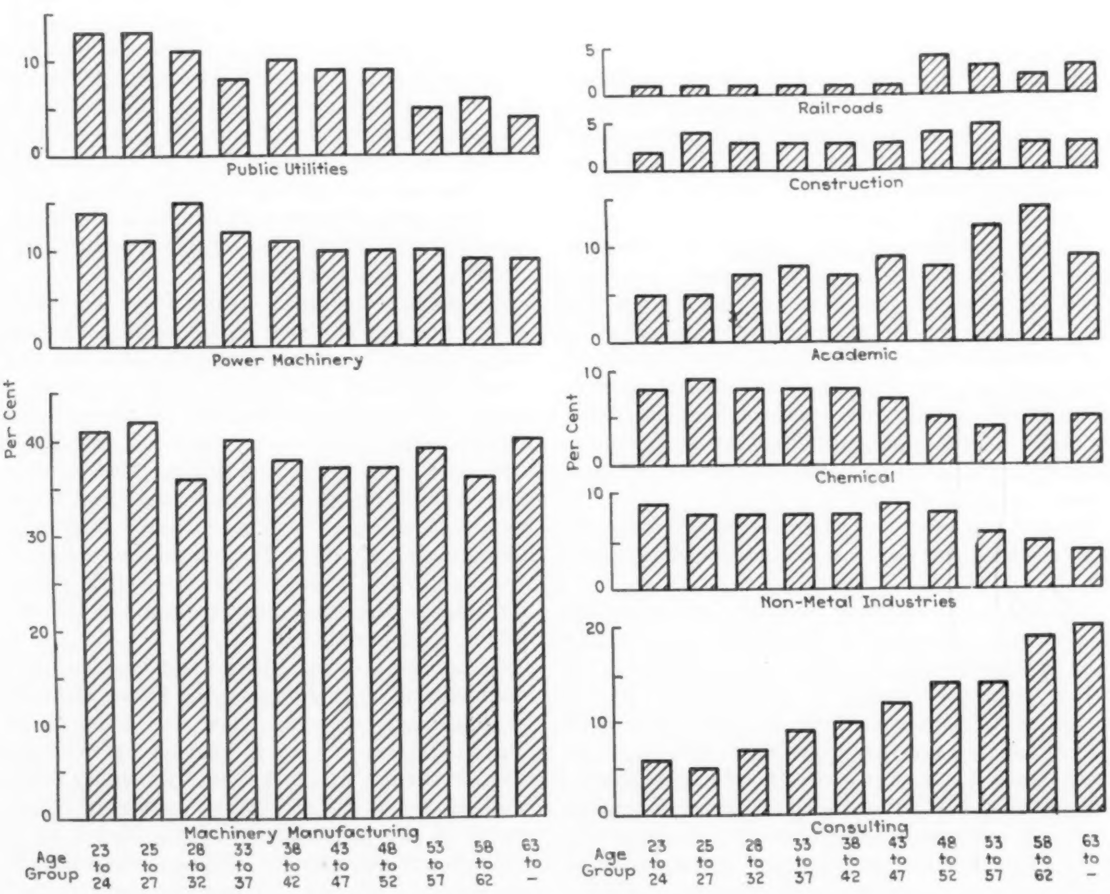


Fig. 2 Industrial Distribution of Mechanical Engineers by Age Groups

Note the relatively larger proportion of mechanical engineers in the earlier as compared with the later age groups in the public-utility, power-machinery, non-metal, and chemical industries, and the relatively small numbers of young engineers in teaching and consulting. Comparison of this chart with the salary boundary charts (Figs. 4–9 infra) shows that this increase or decrease in proportionate numbers in an industry roughly correlates with an increase or decrease in relative incomes except with public utilities, consulting, and teaching.

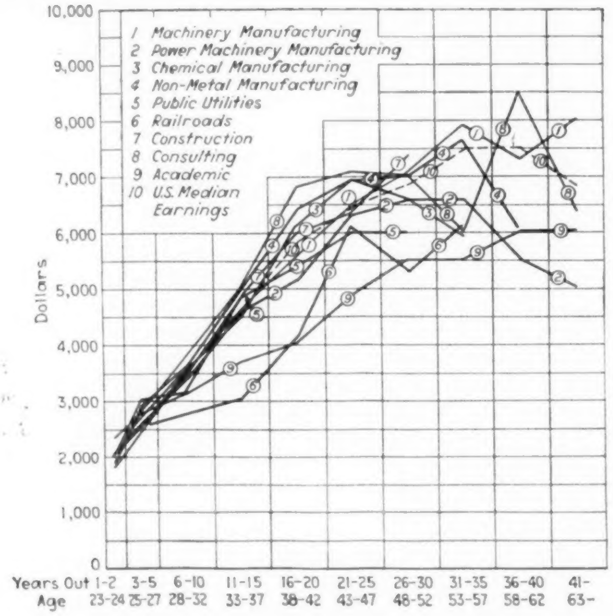


FIG. 3 1930 MEDIAN EARNINGS OF MECHANICAL ENGINEERS BY TYPE OF INDUSTRY

This chart was discussed in detail in the September issue of MECHANICAL ENGINEERING on page 654. Note how slight the deviation between comparative earnings in the different industries is, except in railroads and academic institutions.

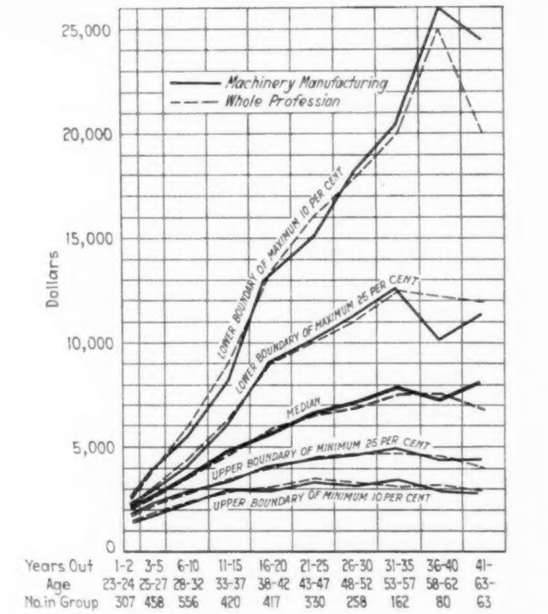


FIG. 4 SALARY BOUNDARIES OF ENGINEERS IN MACHINERY MANUFACTURING INDUSTRIES

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

In this group are included electrical, automobile, airplane, and fabricated-metal-product manufacturing, as well as all machinery manufacturing other than stationary power machinery and railroad equipment.

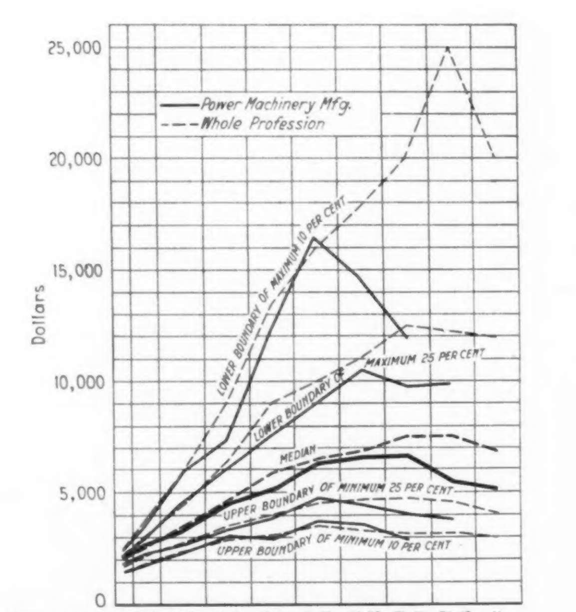


FIG. 5 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN POWER-MACHINERY MANUFACTURING

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

Power-machinery manufacturing includes the manufacturing of stationary power machinery, together with refrigeration, heating, and ventilating equipment. Compare decline in relative earnings with increasing age, with decline in relative numbers with increasing age shown in Fig. 2 supra.

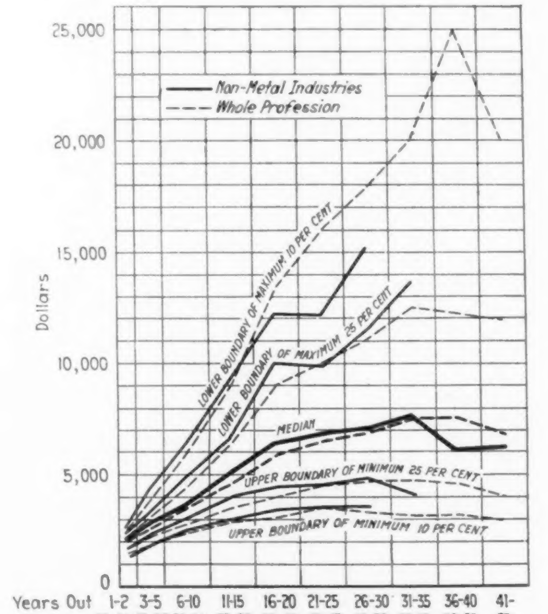


FIG. 6 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN NON-METAL INDUSTRIES

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

This group is a catch-all of those manufacturing industries which, since they deal neither with machinery nor metal or chemical products, are generally less technical. It is interesting to note that they pay younger mechanical engineers more than the more technical manufacturing industries, and that the relative number of engineers employed in them begins to fall off at the ages when relative salaries decline.

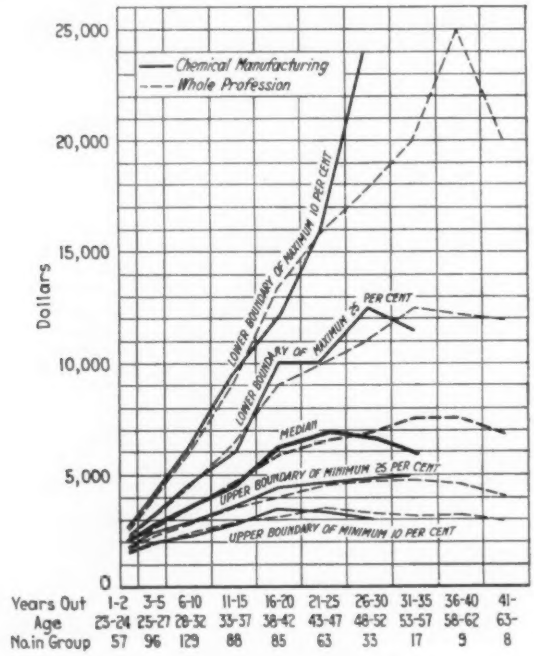


Fig. 7 Salary Boundaries of Mechanical Engineers in Chemical Manufacturing Industries

(compared with general professional standards)

This group includes oil, mining, and metallurgical industries, as well as strictly chemical industries.

In the chart book of the survey of the 1930 economic status of mechanical engineers are plotted full details of the relationship of geographic location, of type of education, of type of industry, and of type of work to engineering earnings. We believe that engineers would rather have access to these charts from which they can draw their own conclusions than any further written statement of the Committee's findings aside from the article published in the September issue of "Mechanical Engineering," on pages 651–656. Accordingly, the most interesting of these charts are given here and in the November issue.

Median earnings—the earnings of the engineer in the middle position in the salary scale—have been used in place of mathematical averages. All U. S. figures are exclusive of teachers and Federal employees. Distribution figures, as well as salary figures, have been based upon the replies of members to the questionnaire. Only such explanatory comments as are necessary to make the significant features of these charts clear are offered, and the curves have been left in unrefined form so as to put the original data, without "smoothing" or other manipulation, directly into the hands of readers.

CONRAD N. LAUER, Chairman,
Committee on the Economic Status of Mechanical Engineers.

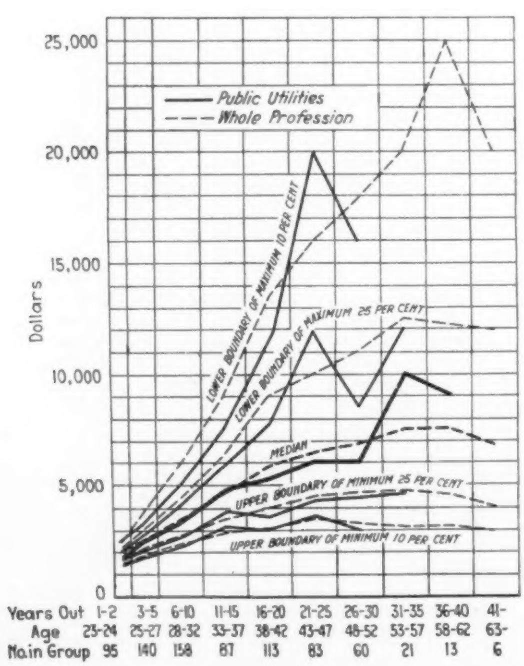


Fig. 8 Salary Boundaries of Mechanical Engineers in Public Utilities

(compared with general professional standards)

Note how the striking concentration of engineers in the younger age groups in this branch of industry, shown in Fig. 2 supra, is not paralleled by relatively high salaries at those ages.

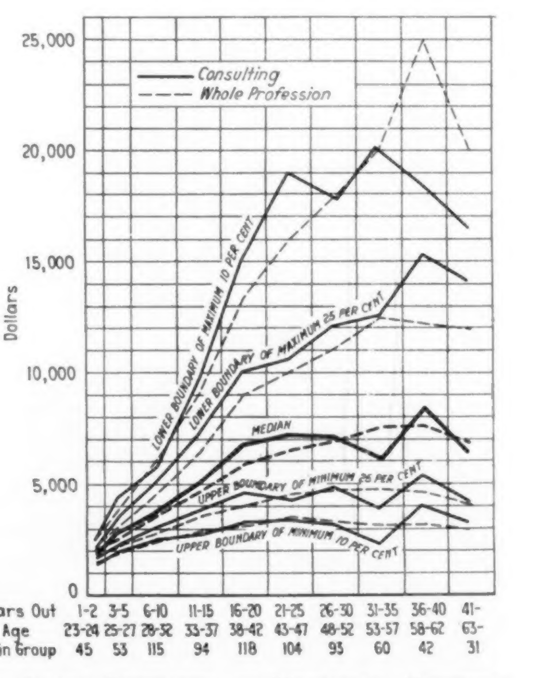


Fig. 9 Salary Boundaries of Mechanical Engineers in Consulting Offices

(compared with general professional standards)

This group includes employees of consulting firms as well as actual consultants. The salary boundaries of men in academic institutions are given in the section relating to "earnings and type of occupation" infra. There were insufficient replies to permit giving salary boundaries for railroads, or for construction, financial, or commercial businesses.

V Earnings and Type of Work

Section 1—Classification on the Basis of Technical Function

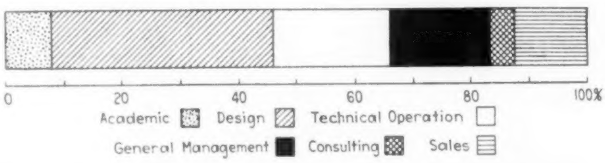


FIG. 10 DISTRIBUTION OF MECHANICAL ENGINEERS BY TECHNICAL FUNCTION

In this and all other classifications in this section great care was taken to adhere to a technical basis of classification. No engineers were classed as managerial unless they had no special technical function. Even vice-presidents in charge of design or sales, for example, were left in the designing or the sales group.

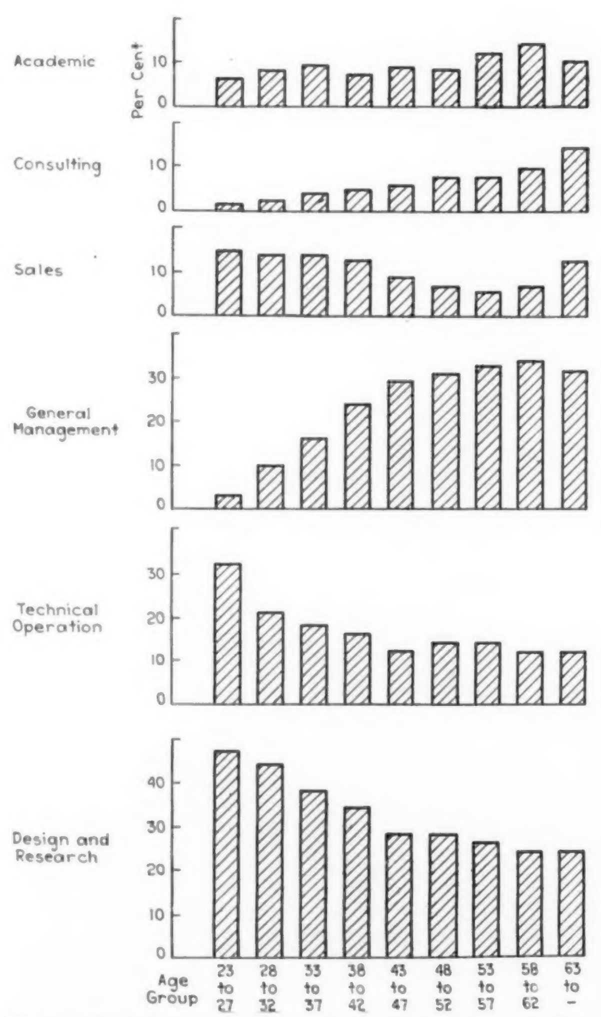


FIG. 11 DISTRIBUTION OF MECHANICAL ENGINEERS AMONG TYPES OF WORK BY AGE GROUPS

The extent to which the technical operation, design, and sales groups decline in proportionate numbers in the later age groups suggests the extent to which men are drawn from them to swell the teaching, consulting, and general-management groups at these ages.

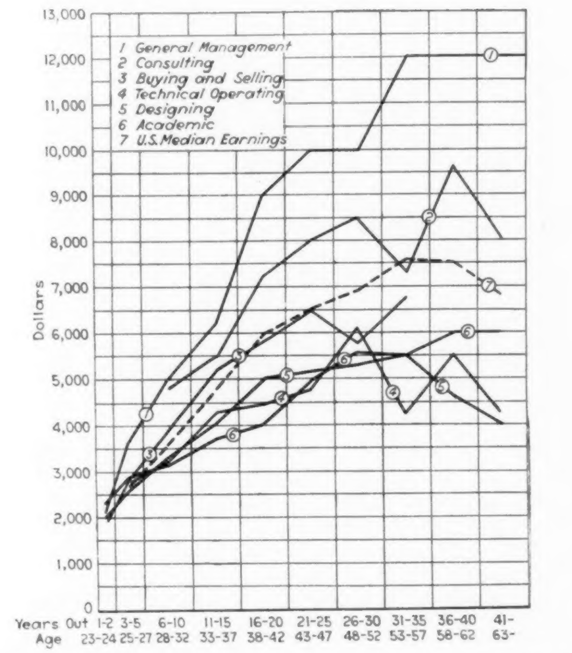


FIG. 12 1930 MEDIAN EARNINGS OF MECHANICAL ENGINEERS BY TYPE OF WORK

Note the striking clustering of the salary curves of all forms of technical work—research and design, technical operating, and academic. This chart is discussed in detail in the September issue on page 655.

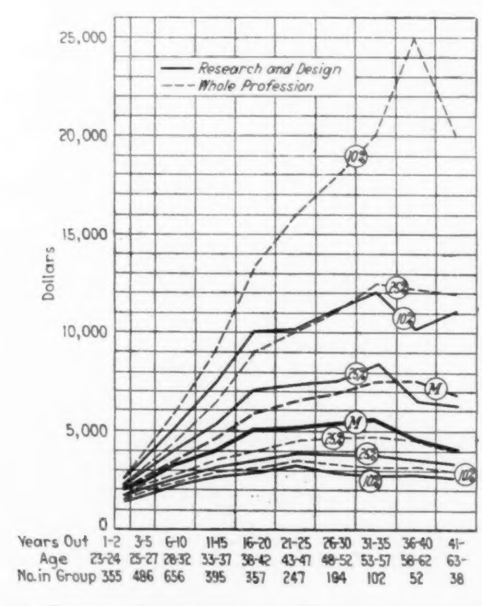


FIG. 13 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN RESEARCH AND DESIGN

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

No men in academic research are included in this group. The salary boundaries of this group and of the technical operating group shown in Fig. 14 are so low that care must be taken to compare each of these boundaries with the *comparable* general professional boundary.

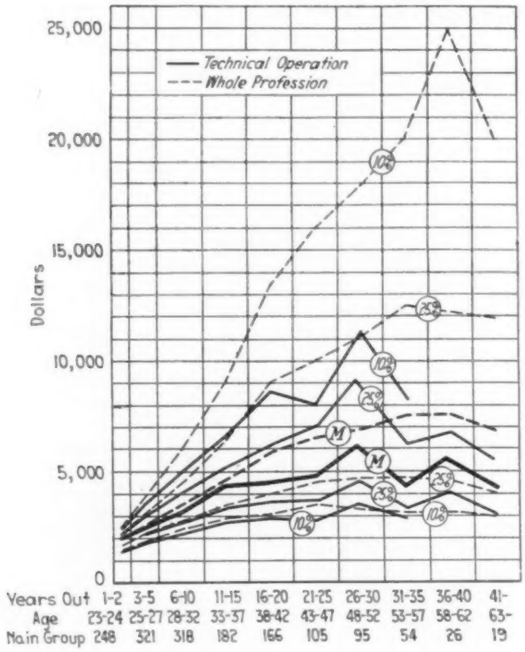


FIG. 14 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN TECHNICAL OPERATION

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

This group includes all men in maintenance, inspection, production control, and other technical aspects of operation, including such executives as plant engineers and chief engineers, except where the technical nature of the product suggested that the chief engineer was primarily in charge of design.

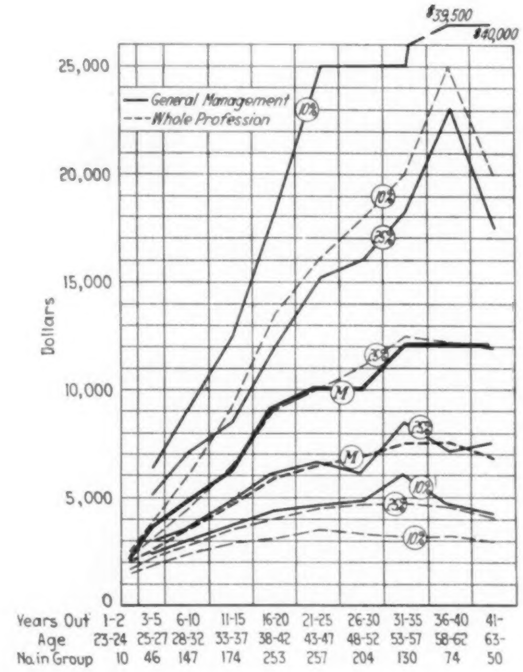


FIG. 16 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN GENERAL MANAGEMENT

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

This group includes primarily those men whose capacity for management so predominated over their technical capacities and interests that they abandoned their technical field for general administrative duties. It includes men entering the general managerial field at all levels from assistant foremen and supervisors to presidents. While it is a group largely recruited by promotion, its relative size indicates how extensively it is open to engineers, while its salary boundaries indicate the range of financial awards for this sort of work.

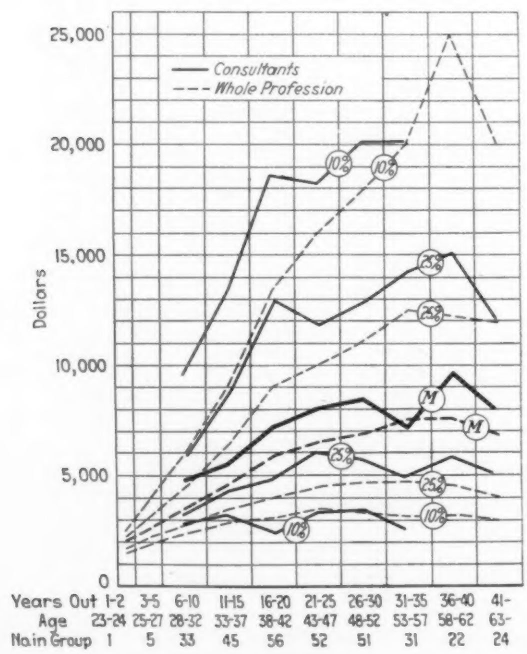


FIG. 15 SALARY BOUNDARIES OF MECHANICAL ENGINEERS WHO ARE CONSULTANTS

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

This group includes only men who are themselves consultants. It is thus much smaller and higher in earning power than the consultant group in the industrial classification, which includes all employees of consulting concerns. This group thus represents only those men who combine with their technical skill, capacity both to deal with clients and to conduct their own businesses.

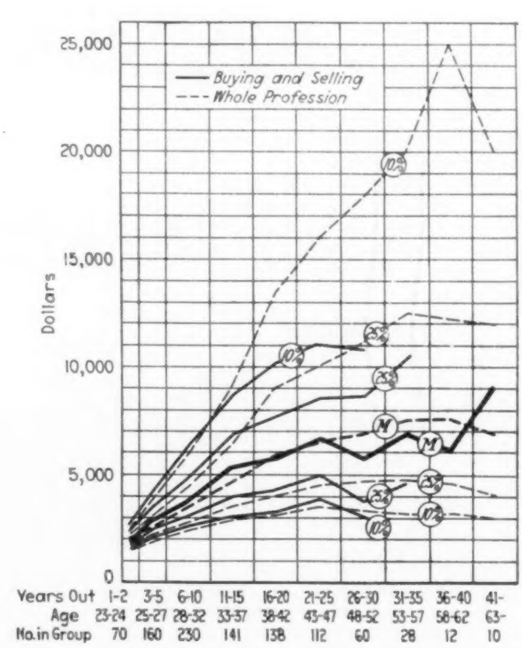


FIG. 17 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN BUYING AND SELLING

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

Note close correspondence of sales median to general professional median.

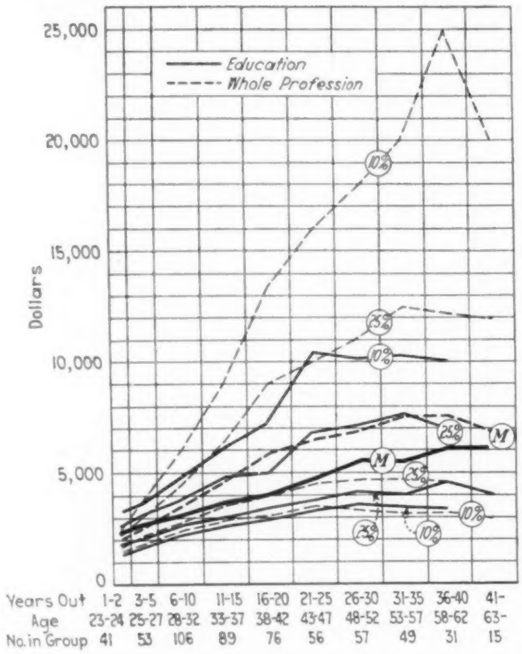


FIG. 18 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN EDUCATIONAL WORK

(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

Here again care must be taken to compare educational salary boundaries with the comparable general professional boundaries.

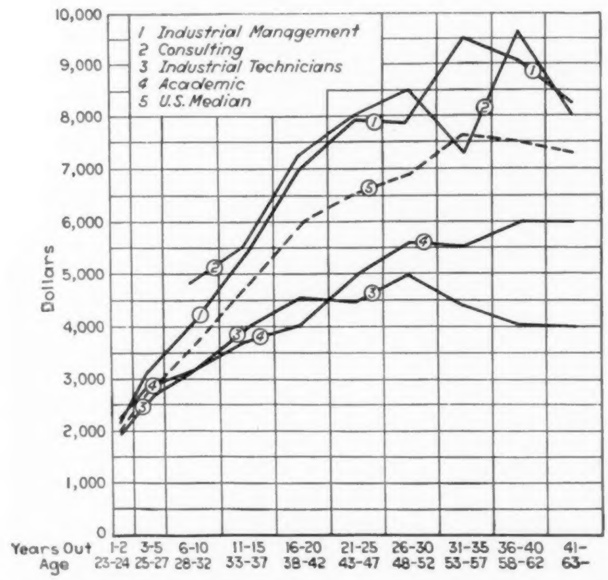


FIG. 21 1930 MEDIAN EARNINGS OF MECHANICAL ENGINEERS IN MANAGERIAL AND NON-MANAGERIAL POSITIONS

The medians for consultants, teachers, and the profession as a whole are inserted for comparison. This chart is discussed in detail in the September issue on page 656.

Section 2—Classification on the Basis of Managerial Function

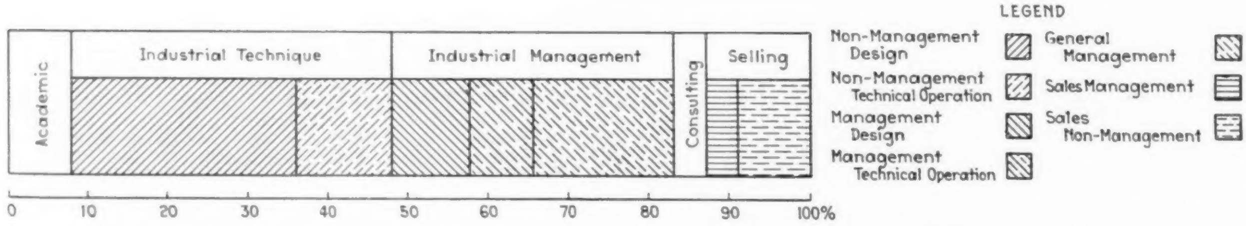


FIG. 19 DISTRIBUTION OF MECHANICAL ENGINEERS BETWEEN MANAGERIAL AND NON-MANAGERIAL TYPES OF WORK

In this section engineers were classified on the basis of whether or not a substantial managerial responsibility was involved in the carrying out of their work. While the former "type of work" classifications were left intact, each was subdivided into a managerial and non-managerial group. This made it possible to build up larger groups on the basis of whether or not substantial executive functions were exercised.

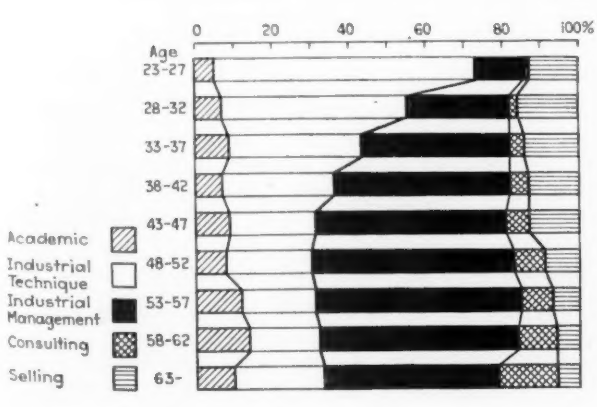


FIG. 20 DISTRIBUTION OF MECHANICAL ENGINEERS BY AGE GROUPS BETWEEN MANAGERIAL AND NON-MANAGERIAL POSITIONS

In this section "Industrial Technique" includes non-managerial design and technical operation, while "Industrial Management" includes all managerial design and technical operation, plus general management. The line between "industrial technique" and "industrial management" shows clearly the migration of engineers into managerial work as they grow older. Note how most of this occurs below the age of 35 years.

(Fig. 21, which is part of Section 2, appears at the top of this column.)

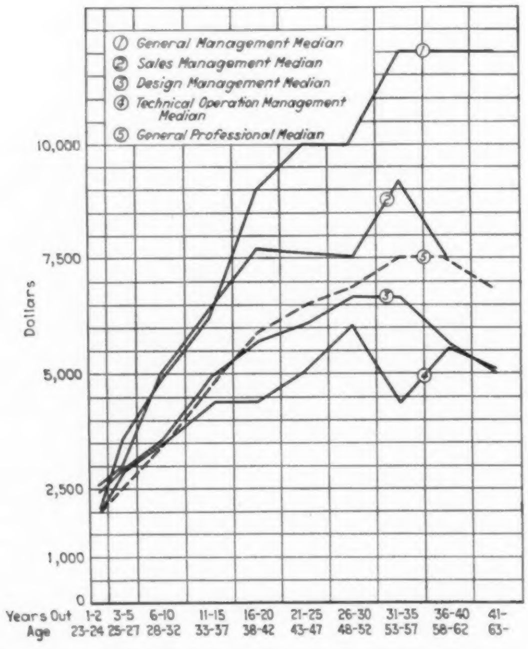


FIG. 22 1930 MEDIAN EARNINGS OF MECHANICAL ENGINEERS IN DIFFERENT TYPES OF MANAGERIAL POSITIONS

Here as elsewhere the "general professional median" is the median earnings of all mechanical engineers, non-managerial engineers as well as managerial.

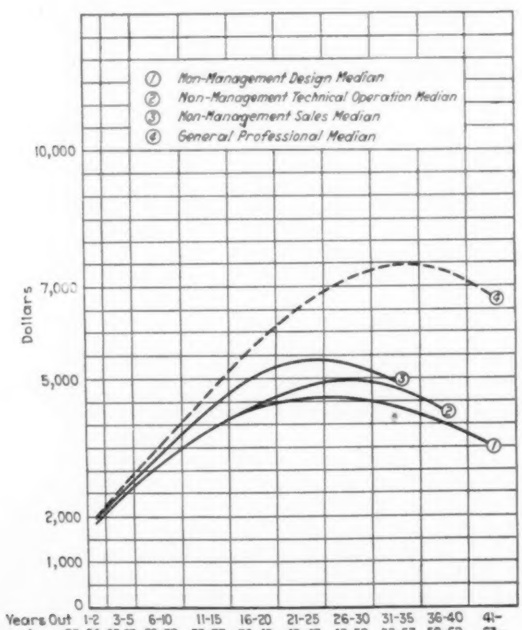


FIG. 23 1930 MEDIAN EARNINGS OF MECHANICAL ENGINEERS IN DIFFERENT TYPES OF NON-MANAGERIAL POSITIONS

In this case it was not possible to use the median curves in their unrefined form, because the medians of the several non-managerial types of work were so interwoven as to be indistinguishable. Accordingly it was necessary to use "smoothed" curves, which, although they do not follow the minor fluctuations in the actual medians, represent the underlying salary tendencies. They give an equally reliable indication of salary levels of the different sorts of non-managerial work. For comparison, the general professional median has also been smoothed

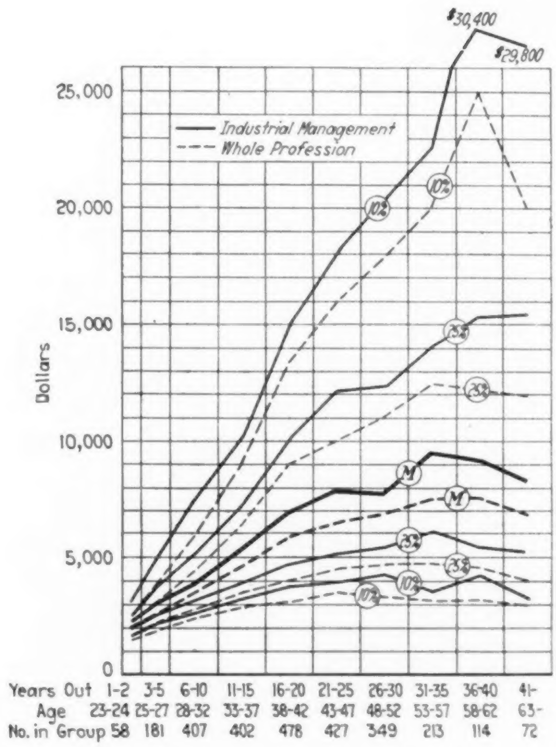


FIG. 24 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN "INDUSTRIAL MANAGEMENT"
(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

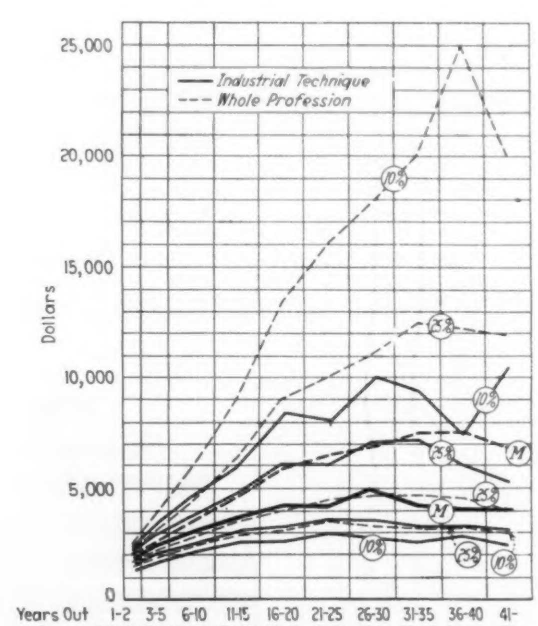


FIG. 25 SALARY BOUNDARIES OF MECHANICAL ENGINEERS IN "INDUSTRIAL TECHNIQUE"
(COMPARED WITH GENERAL PROFESSIONAL STANDARDS)

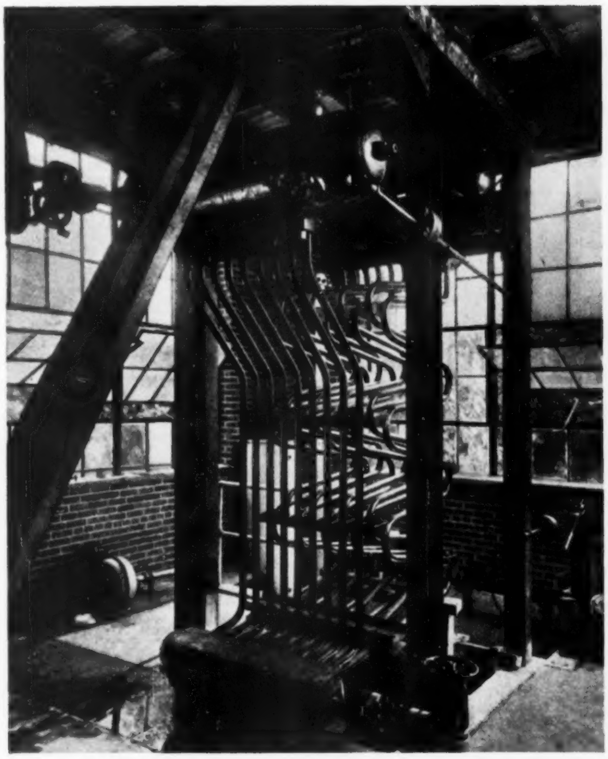


Fig. 1 Before the Boiler Was Enclosed, Showing Steam and Mud Drums, Heating Surface, and Down-Comers

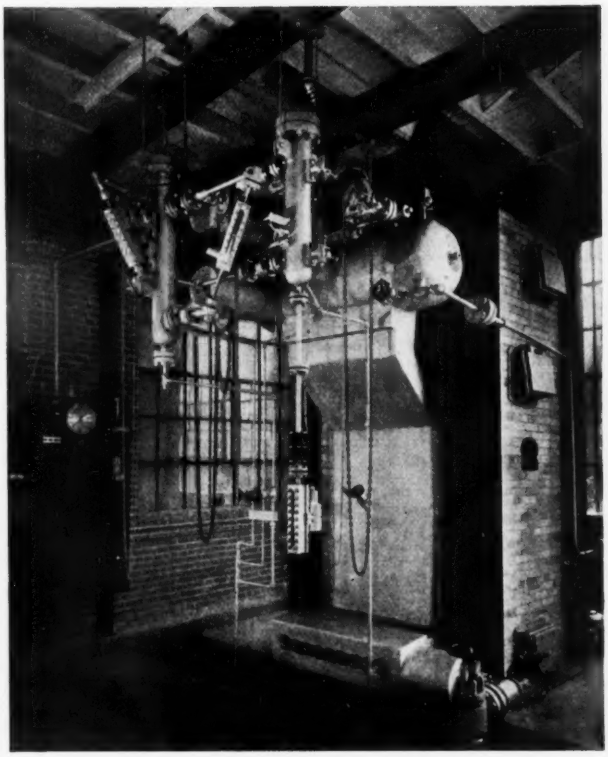


Fig. 2 Rear View of Completed Boiler, Showing Accessories, and Operating Panel at Left

A 2500-Lb. Research Boiler

By D. ROBERT YARNALL,[1] PHILADELPHIA, PA.

A HIGH-PRESSURE boiler to be used for research in developing apparatus for power and industrial plants has recently been installed in the laboratory of Yarnall-Waring Co., Chestnut Hill, Philadelphia. It was designed to provide a controllable water level at 2500 lb. per sq. in. working pressure.

The boiler built by the Superheater Co. consists of a mud drum, evaporating surface, and a steam drum. The evaporating surface is made up of a series of tubes arranged as ascending loops, the terminals of which are connected to the mud and steam drums. This construction eliminates strain due to contraction and expansion where the tubes are connected to the drums. The down-comers from the steam drum to the mud drum for feeding the evaporating surface are located out of the gas pass but inside of the setting so as to prevent the generation of steam at this point.

When steam is generated at 2500 lb. pressure the bubbles are considerably smaller than at lower pressures, so that care must be exercised in the design of a boiler for this high pressure in order that the metal temperature may be kept within a safe operating range. The boiler is so designed that the water is compelled to circulate continuously in one direction, and therefore the sections of the heating-surface tubes that are exposed to the greatest heat always contain water. Not until the gases have cooled down do they come in contact with the tube containing the mixture of steam and water.

The tubes comprising the heating surface are connected to the mud drum by means of a rolled joint opposite which hand-hole openings are provided in the drum, and are connected to the steam drum by means of special clamps which insure a metal-to-metal joint and also eliminate the necessity of hand-hole openings for making this joint. All high-pressure joints in the metal parts of the boiler are on the outside of the gas pass accessible for inspection and maintenance.

The steam drum, having outside length of 5 ft. 10 in., outside diameter of 18 in., and inside diameter of 12 in., or 3 in. wall thickness, is made from a solid forging such as is used on most high-pressure boilers. The mud drum is bored from a solid forging.

The safety valve, made for 2500 lb. relieving pressure, is of the conventional type used on high-pressure boilers. Extra springs are provided for a series of tests

[1] Vice-President and Chief Engineer, Yarnall-Waring Co. Mem. A.S.M.E.

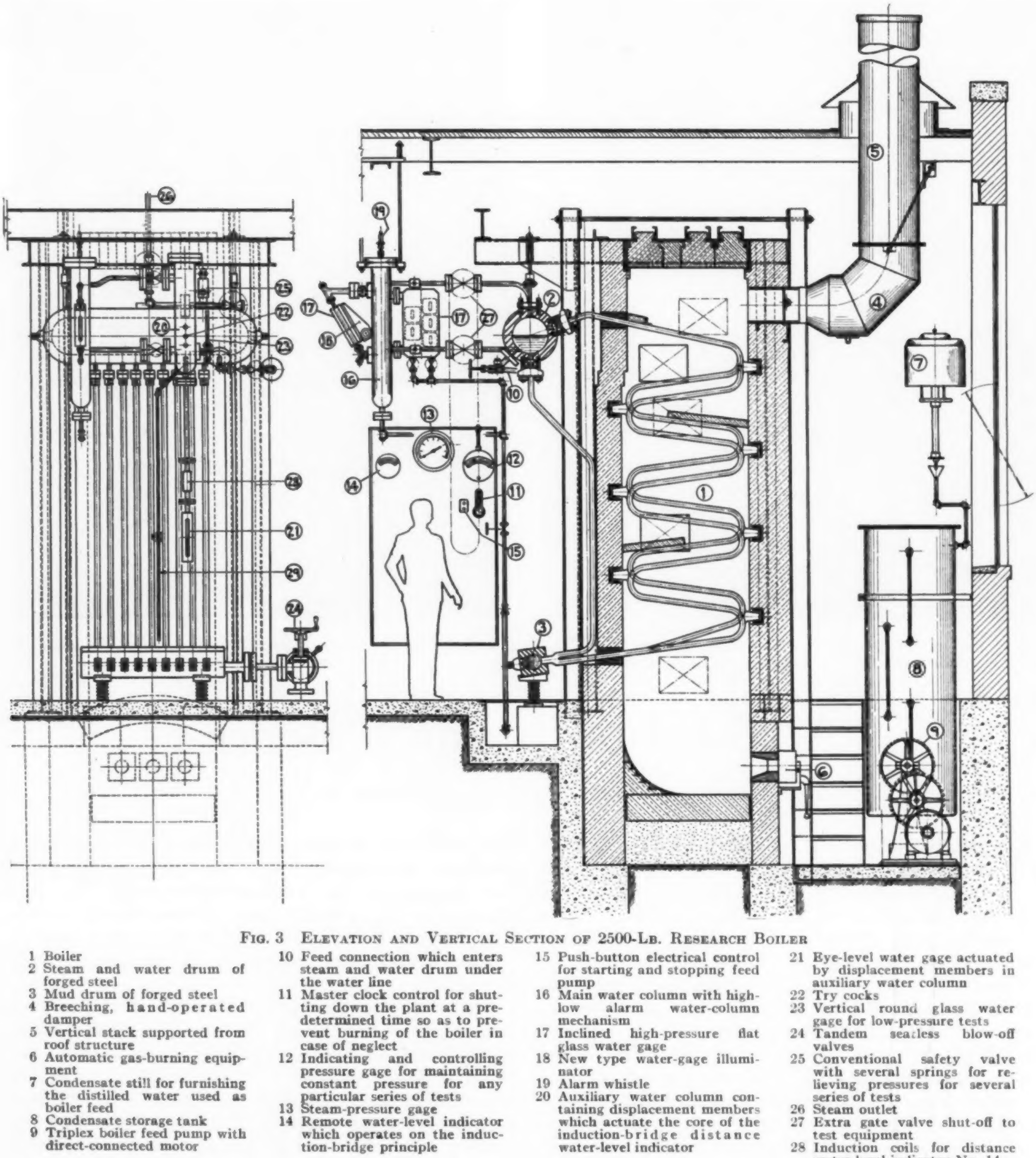


Fig. 3 Elevation and Vertical Section of 2500-Lb. Research Boiler

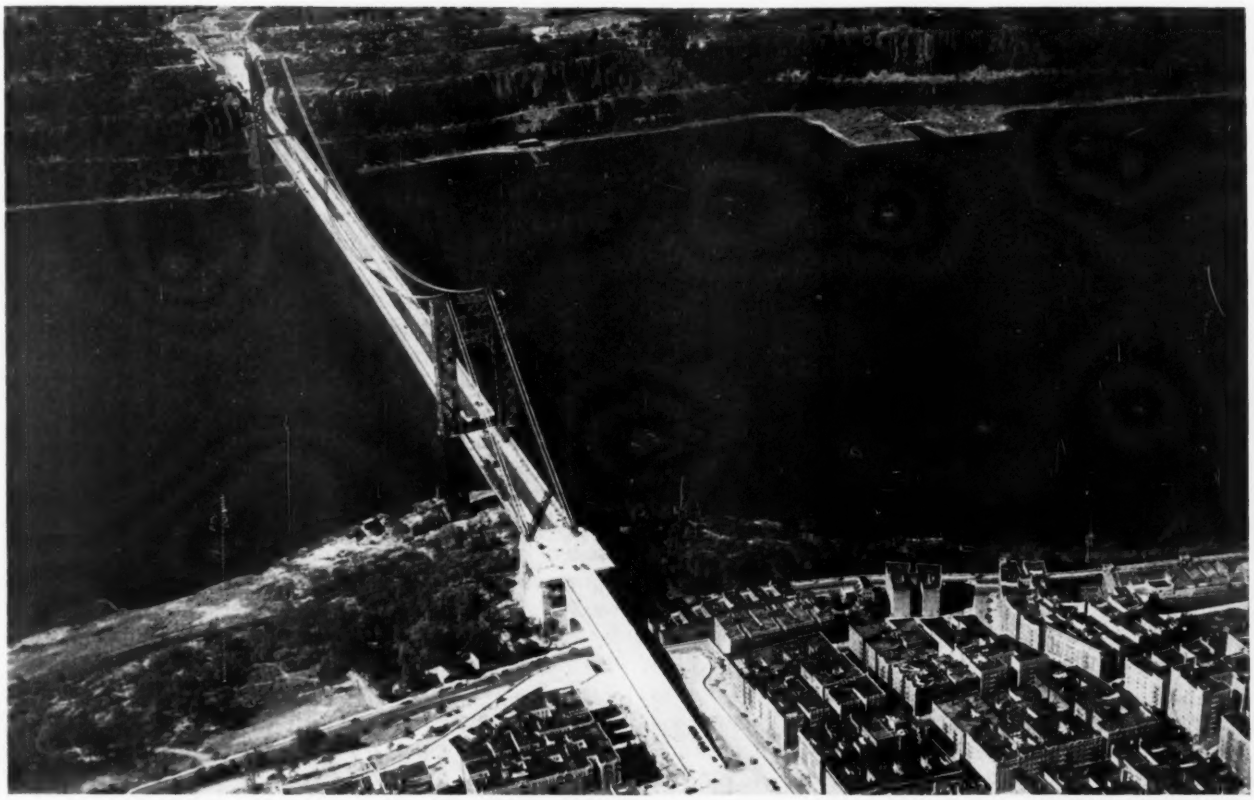
1 Boiler
2 Steam and water drum of forged steel
3 Mud drum of forged steel
4 Breeching, hand-operated damper
5 Vertical stack supported from roof structure
6 Automatic gas-burning equipment
7 Condensate still for furnishing the distilled water used as boiler feed
8 Condensate storage tank
9 Triplex boiler feed pump with direct-connected motor
10 Feed connection which enters steam and water drum under the water line
11 Master clock control for shutting down the plant at a predetermined time so as to prevent burning of the boiler in case of neglect
12 Indicating and controlling pressure gage for maintaining constant pressure for any particular series of tests
13 Steam-pressure gage
14 Remote water-level indicator which operates on the induction-bridge principle
15 Push-button electrical control for starting and stopping feed pump
16 Main water column with high-low alarm water-column mechanism
17 Inclined high-pressure flat glass water gage
18 New type water-gage illuminator
19 Alarm whistle
20 Auxiliary water column containing displacement members which actuate the core of the induction-bridge distance water-level indicator
21 Eye-level water gage actuated by displacement members in auxiliary water column
22 Try cocks
23 Vertical round glass water gage for low-pressure tests
24 Tandem seatless blow-off valves
25 Conventional safety valve with several springs for relieving pressures for several series of tests
26 Steam outlet
27 Extra gate valve shut-off to test equipment
28 Induction coils for distance water-level indicator No. 14

at lower pressures for relieving pressures of 750, 1500, and 2250 lb. per sq. in.

Several types of forged-steel water columns and high-pressure flat and round glass water gages, as shown on the accompanying illustrations, are provided. The blow-off valves installed for test purposes are of the forged-steel seatless type, designed for these high pressures.

The boiler has 130 sq. ft. of heating surface and a furnace volume of 82 cu. ft. It is gas fired from city supply. The rate of combustion is automatically controlled by the steam pressure for the particular test under way at the time and the steam pressure itself is controlled for each test by an adjustable regulator.

An evaporator has been provided, the condensate from which is stored in a vertical tank, shown in the illustrations, from which a motor-driven triplex feed pump provides the necessary boiler feedwater.



Fairchild Aerial Survey, Inc.

SYMBOL OF PROGRESS AND TRIUMPH OF ENGINEERING

(In which most branches of science, engineering, technology, and the arts have been coordinated for the service and convenience of man, for enlarging the influences of trade and communication, and for bridging the difficulties and lack of understanding that come from isolation.)

Technological Progress in 1931

A Review of the Progress Reports of the A.S.M.E. Professional Divisions Which Shows That Technological Advances Have Not Been Halted by Economic Depression

IN THEIR yearly surveys of progress and trends in mechanical engineering the Professional Divisions of The American Society of Mechanical Engineers are able to report many significant examples of technological advance during a period of severe economic depression. At a time when factories are idle or on reduced schedules, when unemployment has become a major social problem, extending with unusual severity to the ranks of engineers themselves, when the uncertainty of economic and financial systems has affected international relations, governments, trade, industry, agricultural, mining, and almost every home throughout the country, the persistent spirit of technological progress has been steadily at work creating new devices, new methods, new opportunities, and new problems. Be it a blessing, as most of us still believe, or something to be feared as enslaving and crushing those who invoke its power to aid man in controlling his material environment, as many others contend, this spirit is an undeniable factor in modern life, in bad times as in good. By means of it, if by any means at all, the materialism which to some is its most potent menace may evolve into a functionalized routine releasing men of future generations from grubbing and back-breaking occupations for the more abundant development of their personalities. An adequate supply of things efficiently produced and properly distributed, easy means of communication and transportation, the safeguarding of the normal physical health of individuals singly and in communities, economic security and self-reliance, and guarantees of man's right and opportunity to attain reasonable satisfactions, will provide the environment in which purposes and values can be more highly esteemed.

In science and technology no such convenient stand-

ards for appraising relative progress exist as are to be found in prices, production statistics, discount rates, gold supply, employment indexes, car loadings, bank deposits, or trade balances. No graph can be drawn with jagged peaks and valleys fluctuating either side of normalcy, because no index numbers can be computed. No evidences of the fatalistic cyclical theory of the eternal return exist, but instead there is an erratic but inevitable forward surge. Through all times, good and bad, the spirit of human progress as reflected by science and technology persists as inevitably as does the principle of organic evolution. The economic depression that has stigmatized the years 1930 and 1931 has called attention with dramatic emphasis to this fundamentally progressive quality of science and technology.

Long after recovery or subsequent depressions shall have effaced the memory of this one, men will make daily use of the George Washington Bridge over the Hudson River, and greater bridges made possible because of what has been learned in its building. The airship *Akron*, so successfully completed this year, takes its place as one of the great steps in aeronautical development. One thousand miles of 24-in. pipe conveying gas from Texas to Chicago, finished during an economic off-season, bear witness to the fact that there is prosperity in some industries. The magnitude of this undertaking, the conservation of natural resources that it makes possible, the benefits to those who, though at a distance, are brought close to the gas fields, excite comment. But without machinery for making pipe cheaply and the development of welding, its impracticability would have prevented the project. In this, as in the steam turbine now in operation under steam at 1000 deg. fahr., progress in one branch of engineering has had to wait upon that in another. Developments in the technology of welding have not only made possible long pipe lines of large diameter, but have brought changes in the design and construction of buildings and of machinery in which, in many cases, castings have been replaced by welded steel. So advanced has the art of welding become and so reliable the tests of the soundness of the welds, that the welding of pressure vessels, under properly safeguarded conditions, has been made permissible this year under the A.S.M.E. boiler code. And as an example of the impress of one development on another may be cited the changes in machine-tool construction and operation being brought about by the introduction of tungsten and tantalum carbide cutting tools.

In the pages that follow are presented the most significant portions of the progress reports submitted by the Professional Divisions of the A.S.M.E. Publication of the reports in full in MECHANICAL ENGINEERING is impossible due to limitations of space, except in cases where the reports themselves are brief. Critical readers who may note omissions should bear this in mind. Many excellent features, such as some extensive bibliographies, and many details and illustrations have regretfully been excluded. Some measure of satisfaction may be derived from the fact that in a year of industrial and commercial stagnation, technological progress has been so great as to make necessary a drastic curtailment of the reports presenting the evidences of it.

The thanks of all engineers are due to those whose especial knowledge of their fields has made them competent not only to report but to view in proper perspective the engineering achievements of the past year. The annual survey of progress and trends that these reports presents makes it possible to evaluate the present situation and orient plans for future action. All engineers will profit from a close study of the following pages which present a substantial review of the extensive reports prepared by the A.S.M.E. Professional Divisions.

Aeronautics[1]

NAVAL AVIATION[2]

DURING the past fiscal year the five-year building program for naval aviation authorized by Congress in 1926 has been completed, and what was planned has been carried out in four years and at an expenditure of $23,000,000 less than the original estimate.

Research in aircraft structural design has progressed satisfactorily during the year. Methods for determining load factors for airplanes more accurately have been devised, with the result that actual knowledge of strength requirements of aircraft structures during maneuvers may be determined. Hull and float design has been vigorously pushed with satisfying results. Several different types of floats have been appreciably reduced in weight, yet maintaining the same strength of structure. This has been due primarily to the use of stainless steel and aluminum alloys for the structures.

Experimental development of new engines of the air-cooled type has proceeded with satisfactory results. The two-row radial air-cooled engine gives promise of satisfactory operation. The advent of dive bombing tactics in the Navy has presented the problem of perfecting the air-cooled engines to withstand higher rotative speeds. The indications from experiments during the year are that the solution of the problem is within reach.

Experimental work with new propellers is continuing. Hollow steel propellers have recently been flight-tested and found to compare favorably with the aluminum-alloy propeller in both weight and performance. Magnesium propellers will be tried, and experimentation for the testing and development of controllable-pitch propellers has been undertaken.

An important tendency in connection with the improvement in performance of naval aircraft is the return from the multipurpose to the single-purpose plane. The present tendency is

[1] The executive committee of the A.S.M.E. Aeronautic Division, whose annual progress report is here abstracted, consists of Elmer A. Sperry, Jr., *Chairman*, Alexander Klemin, *Secretary*, and William F. Durand, Thurman H. Bane, Porter H. Adams, William B. Mayo.

[2] From section of report prepared by Rear-Admiral William A. Moffett, U. S. N.

to place the crew and equipment in the best arrangement for a single-purpose and to design the airplane around this arrangement. Several new naval types under way completely house the wheels in the retracted position. The latest retractable units may be adopted to types other than amphibian.

There has been a growth of employment of radio on airplanes.

Among the improvements in instruments may be mentioned those in equipment for blind flying and navigation. A new type of gyroscopic artificial horizon and direction indicator has been developed, and at the present time the Bureau of Aeronautics, with the cooperation of the Sperry Gyro Company, has under development a gyro compass for use in aircraft.

Of the distinctly naval aeronautical equipment developed by the Bureau of Aeronautics, none is more important than the emergency flotation gear. Its purpose is primarily for the protection of personnel, and secondarily for the preservation of material. It consists of a cylinder of carbon dioxide, inflatable bags, and a system of valves to operate them. The entire emergency flotation gear for a 4000-lb. airplane weighs only 60 lb., and from the pull of the release to full inflation of the bag only 40 sec. is required.

Military Aeronautical Developments[3]

The general trend of development has been toward gradually increasing the speed of all types of aircraft. Speed is the fundamental factor in military aviation, as on it depends to a great extent the combat efficiency of military airplanes. There has been a general increase in operating speeds of new airplanes, obtained by decreases in resistance due to improved construction and by increasing the power of standard engines.

Increases in the power output of engines have been achieved by developing anti-knock fuels permitting higher compression, by the use of superchargers, and by using higher crankshaft speeds. The use of geared engines is also on the increase. As regards superchargers, changes have been made to reduce the head resistance of superchargers, especially of the exhaust turbo type, and lessen their weight. The air-cooled engine is gradually becoming standard for horsepowers below 600, though the radial air-cooled engine still tends to be rough in operation and in the larger sizes the resulting stresses from vibration become serious. Experimentation with controllable-blade propellers has been vigorously pushed, and three different types are now undergoing service tests.

The trend of airplane design is toward the monocoque metal fuselage with all-metal wings. Welded-truss-type fuselages have given satisfaction in service, but may possibly be replaced by welded stainless steel. A great deal of attention is paid to cleanness of design, with resultant decreased head resistance. Skin-stressed wings are more or less general in all new types of airplanes. Both the internally braced thick wings and externally braced thin wings are in use, as neither kind has sufficient superiority to displace the other. The thick wing has the advantage that it provides space in which to retract the landing wheels. This is important, as the present tendency is to retract the chassis with all thick-wing types and, whenever feasible, with thin-wing types.

Among the more efficient materials for aircraft use may be mentioned a synthetic silk fabric which is equal to natural silk for use in parachutes. Stainless steel has been found particularly suited for external tie rods and other parts subject to corrosion, as when properly pickled, highly polished, and rendered passive, stainless steel has from three to four times the corrosion resistance of a cadmium-plated article.

A number of small improvements have been made in fuel and ignition systems, and similar accessories. As failures can generally be traced to inadequate fittings or small breakages due to vibration, such improvements increase the reliability of the power plant. This was strikingly demonstrated by the Air Maneuvers last May (33,064 hr. flown without a serious accident).

Material developments have been made in aerial photography, including night photography and long-distance photography, and a new five-lens camera for photography from high altitudes has been brought out.

Improvements in particular types of military planes have been numerous and important.

In order to obtain a satisfactory primary training airplane that would be reasonably cheap and rugged, a program has been completed which includes the test of all suitable American-made air-cooled engines in the 165- to 185-hp. class.

Among the recent developments in instruments may be mentioned the sonic altimeter, the directional gyro, and the gyro horizon.

Airports and Airways[4]

During the past year the number of municipal airports has increased from 500 to 577 and the number of commercial airports from 558 to 601, these increases being accompanied by the installation of improved airport equipment.

During this period the Federal Government, through the Aeronautics Branch, Department of Commerce, has undertaken the installation of complete landing-field and lighting equipment on approximately 3200 miles of airways, on which contract air mail and passenger service is in operation. It has also established intermediate landing fields and other aids for daylight operation on over 1000 miles on airways, and has commenced surveys for lighting installations during the present fiscal year of approximately 2000 additional airway miles. There are now 17,500 miles of airways lighting in operation on Federal airways. In addition to this, the state of Pennsylvania has established approximately 340 miles of lighted airways, and one of the air-transport companies has lighted approximately 565 miles. A total of 378 lighted and 28 unlighted intermediate landing fields are available for the use of the flying public, and 1934 flashing or revolving beacons are in nightly operation on the Federal airway system. There are approximately 225 certified private aeronautical lights, including 26 beacons operated by the state of Pennsylvania, 19 by the air-mail contractor mentioned above, and 106 by the various terminal airports.

Radio aids to air navigation have increased in number and improved in quality. The Federal-airway teletype system has been extended by 4094 miles, and the United States Weather Bureau has increased the number of stations giving aeronautical information.

Aircraft-Engine Progress[5]

The developments in aircraft engines during the past year have been along the line of improving the existing types. Interesting liquid-cooled engines are being shown by both military authorities and commercial-airplane manufacturers, with the result that a number of American concerns now have large liquid-cooled engines under development.

There has been a considerable improvement in the quality of fuels. Difficulties with overheated cylinders and pistons that have been experienced in the past have been found in many cases to be caused by the employment of fuels having unsuitable detonation characteristics for the compression ratios and heat characteristics of modern aircraft engines. The introduc-

[3] From section of report prepared by D. M. Reeves, Captain, Air Corps, U. S. A.

[4] From section of report prepared by F. C. Hingsburg.

[5] From section of report prepared by Harold Caminez.

tion of definite anti-knock requirements in the current fuel specifications has done much toward eliminating these difficulties. The improved fuels have made possible the development of supercharged engines operating normally with intake manifold pressures appreciably above sea-level atmospheric pressure. This development of ground boosting has been the dominating factor in the reduction in engine weight per horsepower achieved in the past year.

The use of ring cowls has been extended, and it has been found possible to design them so that they will also assist in cylinder cooling. One manufacturer has developed inter-cylinder baffles to direct the cooling blast to the rear of the cylinder barrels and thus aid the cooling efficiency.

With the increase in engine power output, further attention has been directed toward exhaust-valve cooling. Hollow-stem valves filled with metallic salts or sodium have been improved, and the new type of exhaust valve employing a copper-filled stem and valve head has been introduced during the past year.

More importance is being given to the oil as a cooling medium, and this has led to the development of efficient oil coolers. One engine manufacturer has developed a honeycomb radiator located between the carbureter and the intake elbow which acts as a combination oil cooler and carbureter hot spot. Improvements in lubricating oils have permitted the use of higher oil inlet temperatures, and this has increased the efficiency of the oil coolers. Recent improvements made in lead-bronze, steel-backed bearings are making it possible for bearings of this type to carry safely the highest bearing leads now developed in aircraft engines.

Air Transport[6]

Both air and passenger transportation have been affected by the Watres Air Mail Act, which established a space-mile basis of pay for transporting air mail as against the old poundage basis, and provided for the development of a passenger-transport system on the air-mail planes. The volume of domestic air mail has increased, and new contracts for foreign mail have been entered into. The volume of passenger transportation in the first five months of 1931 was below that for the corresponding months in 1930. June, however, showed 1931 ahead of last year. The year 1931 has been outstanding in the development of frequency of schedules in many sections of the country. The increase in number of passengers is particularly gratifying in this, a depression year, when other transportation media are showing decreases.

Accident statistics are given in a table in the complete report. The number of accidents, however, including that of passenger fatalities, is remarkably small. In January–June, 1931, over 4,000,000 miles were flown per fatal accident.

Increased speed has been the keynote of the development of the flying equipment on air-transport lines during the year. This has been accomplished through the purchase of new equipment of high-speed design and the modification of existing equipment to increase its speed.

Up to the time the Watres Bill went into effect, air mail was carried almost entirely in specially designed mail airplanes and passengers in airplanes designed for this purpose. The Watres Bill brought about a change in this condition by requiring that space be provided for passengers where practical. Today the trend is toward combined passenger and mail airplanes for day schedules, with the strictly mail airplane still being used for night schedules where it would be impractical to carry passengers on account of schedule difficulties.

[6] From section of report prepared by A. G. Cameron and D. M. Borden.

Airships[7]

The completion and successful trials of the airship *Akron* have been the high points of airship progress during the past year. The Naval Air Station at Lakehurst has been equipped with mechanical ground-handling gear, primarily for the *Akron*, on a scale never before attempted.

The airship *Los Angeles* took part in the fleet maneuvers in Central American waters during February. She was in continuous operation for three weeks, at a distance of more than 2000 miles from her hangar, using the mooring mast on the U. S. S. *Patoka* as a base for refueling and servicing.

The *Graf Zeppelin* has continued her marvelously successful career. Her most notable flights this year have been to the Arctic and (three times) to South America.

The report of the court of inquiry into the loss of the *R-101* found that the disaster was the culmination of a chain of adverse circumstances.

An experimental non-rigid airship, designated the *K-1*, has been completed for the U. S. Navy. The volume of this airship is 320,000 cu. ft., which is about 50 per cent larger than any other non-rigid airship built since the war. She has been designed especially for experiments with fuel gas contained in a ballonet completely surrounded by helium.

Progress in Aerodynamics[8]

The year 1931 has not been noteworthy for radical progress in aerodynamic research in the United States. The National Advisory Committee for Aeronautics during this period has put into actual operation the world's largest wind tunnel—built to accommodate a full-sized airplane—and the world's largest water channel, in which it is possible to make tests on even certain full-sized floats. Probably more progress has been made in theoretical than applied aerodynamics, judging from the increasing number of reports of such nature now being issued by our own National Advisory Committee for Aeronautics and by the staffs of the aeronautics departments of the various universities. However, the development of the autogiro in this country has widened the scope of aerodynamics considerably.

In the field of pure aerodynamic research, most of the activity has been directed toward methods of boundary-layer control. The National Advisory Committee for Aeronautics in this country, as well as various other laboratories throughout the world, have issued reports covering tests pertaining to the increase of lift or reduction of drag by the removal of the boundary layer in the vicinity of the surface of the body. The results of this research are mainly of academic interest at present, but practical application of them in increasing the lift of wings may be made in the near future.

Aircraft Design and Construction[9]

The aircraft designer in 1931 seems to have devoted most of his attention to the reduction of initial cost of the airplane and its cost of operation, and to increase of speed.

The higher performances actually achieved have not been due to basically new features of design, but rather to the use of increased engine power, better attention to parasite drag, and elimination of interference.

Aircraft engines have been increased in power with little change in weight. It is becoming more common on high-speed commercial planes to use engines with high blower ratios, giving some supercharging at sea level. Supercharged high-compression engines have been used on practically all of the racing planes.

[7] From section of report prepared by C. P. Burgess.
[8] From section of report prepared by W. H. Miller.
[9] From section of report prepared by R. M. Mock.

The need for satisfactory engines above 600 hp. and engines of 300 to 600 hp. of cleaner design has been felt as a handicap to further progress in the development of airplanes. Except for one engine there are none quite large enough for the transport class, while the increased speed of the airplane in the 90- to 160-hp. field has been in a great measure due to the engines.

Among aerodynamic improvements of the year may be mentioned the retractable landing gear and the cantilever or wire-braced undercarriage with streamlined wheels. Wheel fairing, though common on racing and some sport planes, has proved impracticable for commercial use.

In fuselage design the tendency has been toward oval and round cross-sections, with as few external protuberances as possible.

In longitudinal stability and control little has been done in this country, but in Germany Alexander Lippisch has brought out a low-wing tailless design with great taper and not excessive sweepback, which appears to be efficient and worthy of future development.

The new Junkers 700-hp. Diesel engined freighter is understood to have very efficient control surfaces; the ailerons, as on the Junkers G-38, are small auxiliary airfoils below the main wing with the leading edge of the auxiliary airfoil a little in front of the trailing edge of the main wing, leaving a slot between the main and auxiliary airfoils. The elevator control is similar except that the movable surface (the elevator) is above the fixed surface (the stabilizer). The advances made during the year with the Sperry gyroscopic pilot cannot go unmentioned as they will surely influence future air transportation, especially in bad-weather flying.

An interesting aerodynamic development started during the year has been the full-flight investigation by the Fokker Aircraft Corp. of the effects of vanes or deflector airfoils or slots on fuselage and cockpit corners to reduce drag. This seems to offer great promise.

The popularity of the monoplane in this country continues to increase, 64 per cent of the commercial planes produced during the first half of the year being of this type. A great number of so-called "home-made" planes have been powered with motorcycle or Ford automobile engines.

Among the large transport planes, toward the close of the year the single-engine passenger transport has shown signs of increasing popularity, because of its economy of operation and the fact that when following more or less conventional lines, it is easier to get high performance with the single-engine design.

Nevertheless there seems to be some indication that a number of manufacturers will follow the arrangement of the Fokker XO-27 military land plane having a cantilever monoplane with two engines faired into the leading edge of the wing, one on each side of the fuselage and with landing gear retracting behind each engine. This type has already established itself for efficiency for both observation and bombing types, and there is every indication that it will work out as a fast transport type also. Basically the engine arrangement is not new. It was first brought out in the Dutch Fokker T-IV high-speed twin-float monoplane seaplane some years ago.

In the United States the tendency in the transport field seems to be toward 10- to 12-passenger planes with frequent schedules rather than larger and less frequently operating planes. For transcontinental operations larger machines are necessary, and it is understood that Ford is completing a 30- to 40-passenger four-engined transport with two radial engines located in the leading edge of each wing and two water-cooled engines located in tandem above the fuselage. Abroad the opposite tendency is evident.

The rotating-wing or blade type of plane has made considerable progress in the past year or so, particularly through the efforts of Harold Pitcairn with the autogiro. This aircraft has received the approval of the Aeronautics Branch of the Department of Commerce.

As this is being written, the Buhl Aircraft Corporation is completing its first autogiro. As autogiros go, it is quite unconventional, being a two-seater, 165-hp. pusher-type machine with an outrigger tail supported by three members, one from the wing on each side and one from the top of the rotor pylon.

In contrast with the autogiro development is that of E. Burke Wilford, of Philadelphia, Pa., with his "gyroplane," a self-rotating type of craft with rigid blades of comparatively small diameter feathering automatically by having the center of pressure of the blade, and consequently most of its area, located slightly behind the axis of support, causing the blade to turn about this axis and changing the angle of incidence. By having diametrically opposite blades interconnected this torsional movement produces the proper feathering action.

Another development, publicized widely but about which little could be learned, has been the flights of the Pescara helicopter in Barcelona, Spain.

Another important development is an improved shaft drive for airplane propellers, as evidenced by the drive shafts and gearing for the dirigible *Akron*. This development enables engines to be located within the craft, perhaps within the wing, hull, or fuselage where balance and other conditions dictate, and yet have the propellers in their most efficient locations.

Other developments worthy of mention are the Ford mail compartment located in the wings outboard of the side engines, and the Perry ski-wheel unit brought out by the Aircraft Products Corporation, allowing flights from either land or snow with a simple gear changeable in the air. Greater safety against fire should be brought about through the venturi-type, low-temperature exhaust manifold developed by the N.A.C.A.

Applied Mechanics[1]

THEORY OF ELASTICITY[2]

DURING the past year the papers read at the third international congress on Applied Mechanics which took place in Stockholm in August, 1930, were published. A review of these papers appeared in the November, 1931, issue of MECHANICAL ENGINEERING, p. 850. Many of the papers presented were in the field of elasticity and represent clearly the recent progress in this field. The following subjects were discussed at the congress:

1 Various theories of strength
2 Plasticity
3 Elastic stability.

The general development of strength theories and plasticity was discussed in a lecture by R. von Mises. The development of the strength theory for polycrystalline specimens when the prop-

[1] The executive committee of the A.S.M.E. Applied Mechanics Division, whose annual progress report is here abstracted, consists of A. I. Kimball, *Chairman*, J. M. Lessels, *Secretary*, and George B. Pegram, J. A. Goff, F. M. Lewis.

[2] From section of report prepared by S. Timoshenko.

erties of a single crystal are known was given in a paper by M. Ros and A. Eichinger. The plastic flow of metals in the case of two-dimensional problems was considered in the papers by A. Nadai and Pollaczek-Geiringer. Among the papers discussing stresses in machine parts may be mentioned those by E. Honegger and by A. M. Wahl in which a detailed analysis of stresses in close-coiled helical springs was given and in which Belleville springs were also considered. A paper by R. C. J. Howland gave the solution of the problem of stress concentration produced by a circular hole, if the width of the plate is not very large in comparison with the diameter of the hole. A new development in photoelasticity was discussed in the paper by Ziro Tuzi. Mr. Tuzi uses for his photoelastic work monochromatic light, and instead of colored pictures gets fringes on the image of a stressed model. These fringes furnish a very accurate method for determining maximum shearing stresses. For obtaining the principal stresses Dr. Den Hartog suggested the use of a membrane.[3] Mr. Tuzi also developed the application of cinematography in photoelasticity. His methods have been successfully applied in this country by Dr. M. Frocht.[4]

A considerable number of papers at the Stockholm congress dealt with elastic stability. A general lecture on stability and strength of thin-walled constructions was given by S. Timoshenko. In this lecture several engineering problems were mentioned in which elastic stability is an important factor. The elastic stability of a thin plate under compression was discussed in papers by G. Schnadel and E. Melan. The important problem of the stability of a rectangular plate under the action of shearing stresses was discussed in papers by S. Bergmann and E. Seydel. Stability of beams of variable depth against lateral bucking was discussed by K. Federhofer. A general discussion of the stability of a compressed bar by using the theory of large displacements was given by E. Trefftz.

In this country the problem of elastic stability of compressed plates was investigated experimentally by the Bureau of Standards and theoretically in a paper by Th. von Karman, E. E. Sechler, and L. H. Donnell.[4]

Vibration[5]

In vibration-elimination work, an outstanding contribution has been the development, by Thearle, of an automatic dynamic balancing machine for balancing rotating bodies, described at the June meeting of the Applied Mechanics Division at Purdue, which for beauty of design and speed of operation is unsurpassed. Progress has been made in the art of cushioning vibrating rigid bodies against transmission of vibration and noise, as reported on at the Rochester meeting of the A.I.E.E. by Hull and Stewart. The use of complex notation in the analysis of vibration problems has been further perfected for practical use. This is employed in the last-mentioned paper, and a brief discussion of its basis was given by Hull to the Applied Mechanics Division at the June meeting.

Further causes of shaft vibration were brought out by Soderberg at the same Applied Mechanics meeting, and vibration damping has received its share of attention. A paper by Den Hartog in the *Philosophical Magazine* on this subject gives an exact solution for a vibrating system with combined viscous and "Coulomb" damping.

A paper by F. Neugeberger in *Technische Mechanik und Thermodynamik* for April, 1930, is of interest, discussing as it does the action of dampers and optimum damper sizes very fully. Of exceptional interest also is the founding in Germany of the Heinrich Herz Institute for Vibration Research. The work of the institute covers electrical and mechanical vibrations and sound.

Mechanics of Materials[6]

The importance of the question of working stresses, especially for combined stresses, is again being emphasized. A symposium published in *Maschinenbau*[7] clearly indicates the inadequacy of the Bach criterion of 1:2:3 for static, sudden, and alternating loading.

Considerable work has been done on the effect of temperature on the properties of metals, as evidenced by the A.S.T.M.-A.S.M.E. symposium[8] in Chicago, June 23, 1931. The testing of metals at elevated temperatures has also progressed abroad, particularly in England and Germany.

Cohesion strength[9] appears to be of fundamental significance. It has been suggested that fatigue and cohesion failure are related phenomena.[10]

A damping test of materials as developed in the laboratory of O. Föppl in Braunschweig, Germany, has been introduced in this country.[11]

The widespread use of welding has given impetus to considerable research work concerning the strength of welds[12] and the fatigue strength of welded specimens.

An interesting method of testing wire in fatigue has been developed[13] whereby the additional stress due to the weight of the wire itself causes fracture to occur away from the grips and thus eliminates stress-concentration effects. A comprehensive investigation has been carried out at the U. S. Bureau of Standards in comparing endurance limits for bending and axial stressing.[14]

Thermodynamics[15]

In the last few years interest in thermodynamical problems has increased. Besides the well-known investigations of the properties of steam, numerous experiments of a fundamental nature have been undertaken to discover underlying principles governing vaporization, condensation, heat conduction, heat transfer, combustion, etc. Moreover, engineers have shown an increasing disposition to follow the guidance of thermodynamic laws to new and more efficient cycles of operation in the fields of power generation, refrigeration, and domestic heating.

Osborne[16] has reported on the progress in steam research at the Bureau of Standards, while Keyes and Smith[17] and Smith and Keyes[18] have published final values for the properties of saturated and superheated *water*, and new additional volume data

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[3] See *Zeit. f. Angew. Math. u. Mech.*, 1931.

[4] Purdue Meeting, Applied Mechanics Division, June, 1931, See Trans. A.S.M.E., APM-53.

[5] From section of report prepared by F. M. Lewis.

[6] From section of report prepared by R. E. Peterson.

[7] "Zulässige Spannungen der im Maschinenbau verwendten Werkstoffe," *Maschinenbau*, vol. 10, no. 3, p. 66.

[8] "Symposium on Effect of Temperature on the Properties of Metals." Publication issued jointly by A.S.T.M. and A.S.M.E. Includes twenty-eight papers and a bibliography.

[9] Ludwik, "Schwingungsfestigkeit und Gleitwiderstand," *Zeit. f. Metallkunde*, Nov., 1930, p. 374.

[10] Kuntze, "Struktur, Festigkeit, Stätigkeit," *Z.V.D.I.*, March 7, 1931, p. 285.

[11] Heydekampf, "Damping Capacity of Materials." Paper before A.S.T.M., June 23, 1931.

[12] "Symposium on Welding," March, 1931. Publication by A.S.T.M. Includes eleven papers.

[13] Shelton, "Fatigue Testing of Wire," A.S.T.M. Annual Meeting, June, 1931.

[14] France, "Endurance Testing of Steel—Comparison of Results Obtained With Rotating Beam Versus Axially Loaded Specimens," A.S.T.M. Annual Meeting, June, 1931.

[15] From section of report prepared by John A. Goff.

[16] N. S. Osborne, Mechanical Engineering, vol. 53 (1931), p. 137.

[17] F. G. Keyes and L. B. Smith, Mechanical Engineering, vol. 53 (1931), p. 132.

[18] L. B. Smith and F. G. Keyes, Mechanical Engineering, vol. 53 (1931), p. 135.

for superheated *steam*. Trautz and Steyer[19] have also published new data on the properties of water up to 500 deg. cent. and for pressures exceeding the critical up to 300 kg. per sq. cm. Keenan[20] has made use of the Keyes and Smith data to calculate the work of reversible adiabatic (isentropic) compression of liquid water and the heat added at constant pressure after compression.

The behavior of steam near the critical point, or in fact the existence of a critical point, remains a mooted question. The American workers have stated values of 225.8 kg. per sq. cm. and 374.1 deg. cent. for the critical pressure and temperature; but the late Professor Callendar for several years contended that above 374 deg. cent. there is an unstable region in which water and steam form mixtures, and only above 257 kg. per sq. cm. and 380.5 deg. cent. is a uniform state to be found. While the experiments of W. Koch,[21] of Munich, have failed to confirm Callendar's contentions, they cannot properly be regarded as disproving them or of finally disposing of the question.

As an interesting example of the growing tendency to employ the methods of experimental physics in the solution of problems in thermodynamics may be mentioned the work of Henning and Justi.[22] The photographic method of measuring temperatures proposed by Hencky and Neubert[23] may lead to a solution of the present difficulties of eliminating the effects of heat conduction, etc. which render many of the measurements of surface temperatures by present means inaccurate.

HYDRODYNAMICS AND AERODYNAMICS[24]

That the problems of turbulence and fluid resistance must be considered the two fundamental problems in hydrodynamics is clearly indicated by the large number of papers devoted to these subjects which were presented last year before the Applied Mechanics Congress at Stockholm, Sweden.

Two phases of the problem of turbulence must be considered:

1 The generation of turbulence, i.e., the change from laminar to turbulent flow, and
2 The mechanism of turbulence.

Regarding the solution of the first phase, a step forward has been made by W. Tolmien.[25] The theory developed by him gives, for the first time, a critical Reynolds number which checks fairly well with experiments, taking into account the approximate character of the calculation.

With respect to the explanation of the turbulence itself a paper has been written by Th. von Kármán in which he succeeded in determining important features of the turbulent flow in a purely theoretical way. Very successful experimental work is under way at Göttingen, Germany, regarding the structure of turbulent flow.

Fluid Resistance. Considerable work has been done to determine the pressure drop in smooth and rough pipes for very high Reynolds numbers. The relationships between the variables involved seem to be less complicated for rough pipes than for smooth ones.

The desire for faster transportation has given rise to tests on the effect of streamlining trains and interurban cars. Extensive tests and calculations have been made on ship resistance and new forms of ship bows have been developed to reduce wave resistance.

Cavitation. The trend toward higher speeds and larger sizes of pumps, water turbines, and ship propellers, has led to much excellent work on cavitation. By using high-speed moving pictures, it has been possible to obtain a fairly good knowledge of the mechanism of cavitation. However, comparatively little has been published, which shows how the performance, and particularly how the efficiency, is affected by cavitation, and how its occurrence can be avoided by suitable design.

Fluid Flow. Airfoil theory has been applied to the design of Kaplan turbines, propeller pumps, and fans, but there is a lack of tests of the performance of pumps, fans, and turbines of different constructions.

The theory of flow of gases above the acoustic velocity has been enlarged, particularly by a new method of determining compression shocks in two-dimensional gas jets. In addition, a new theoretical method has been developed to predict the performance of thin airfoils and to determine the mutual interference between them.

Airplane Performance. A large amount of detail information on airplane performance has been accumulated, mostly by wind-tunnel tests. The trend in making these tests with larger and larger Reynolds numbers in order to eliminate any possible scale effect has resulted in the building of a new full-scale wind tunnel at Langley Field, Virginia, and a new high-pressure wind tunnel in England.

Theoretical work has been done, particularly in England, in calculating the spinning characteristics of airplanes. Several vertical wind tunnels have been built for studying the spinning problem. One of them is at Langley Field, Virginia, and another in Göttingen, Germany. The latter uses water instead of air, obtaining thereby larger Reynolds numbers and a better possibility of measuring the forces involved.

LUBRICATION[26]

Studies in lubrication have been pursued in several directions. Work has been done on the hydrodynamical theory of lubrication as well as on the properties of lubricants, properties of bearing metals, and mechanism of wear.

In the first group, the paper presented by Albert Kingsbury[27] is outstanding. He proposes a comparatively simple experimental way of treating problems in perfect lubrication, instead of employing the difficult analytical method. The analogy between electrical potential and oil flow is used.

Experiments with a view to verification of the hydrodynamic theory have been in progress in various laboratories in universities and industrial institutions.

Much attention has been paid to establishing methods of laboratory testing the lubricating value of oils. An oil which has passed all physical tests, such as density, viscosity, flash and fire points, etc., is not necessarily a good lubricant. J. G. O'Neill[28] has described the work done by the U. S. Navy, improving the technique of testing turbine, Diesel, and aviation oils. The problem of measuring oiliness (whatever may be defined under this term) has occupied the attention of several laboratories. As "film strength" the lubricating quality of oils has been measured by C. M. Larson.[29] The lubricating quality of oils has been investigated also by the National Physical Laboratory in England and by other European laboratories.

[19] M. Trautz and H. Steyer, *Forschung a.d. Gebiete des Ingenieurwesens*, vol. 2 (1931), p. 145.

[20] J. H. Keenan, MECHANICAL ENGINEERING, vol. 53 (1931), p. 127.

[21] See M. Jakob, *Z.V.D.I.*, vol. 75 (1931), p. 971.

[22] F. Henning and E. Justi, *Zeit. f. techn. Phys.*, vol. 11 (1930), p. 191. E. Justi, *Forschung*, vol. 2 (1931), p. 117.

[23] K. Hencky and P. Neubert, see M. Jakob, *Forschung*, vol. 2 (1931), p. 267.

[24] From section of report prepared by O. G. Tietjens.

[25] Reported at Purdue Meeting.

[26] From report prepared by G. B. Karelitz and L. M. Tichvinsky.

[27] Trans. A.S.M.E. (1931), APM-53-5.

[28] "The Evaluation of Lubricating Oils by the Work-Factor Method," A.S.M.E. Paper, 1930 Annual Mtg. and Am. Standards Assn. Bulletin no. 58, Feb., 1931, pp. 3–9.

[29] "Classifying Transmission and Rear Axle Lubricants," *S.A.E. Journal*, March, 1931, p. 321.

Fuels and Fuel Utilization[1]

THE retrenchment of general business activity during the past year has not taken place without leaving its mark upon the production and utilization of fuels. The production of mineral fuels has followed pretty much the trend of industrial activity as measured by various indexes. Some of the industries dependent upon the utilization of fuels have suffered appreciably, while others, particularly the gas industry and power companies, show but little decline. The distribution of new equipment has suffered an especial setback. Progress in methods of utilization shows conflicting trends.

Research on fuels and their utilization has been apparently stimulated this year by virtue of economic conditions.

As regards fuel utilization, generally the tendency has been mixed. It should be remembered that increases in thermal efficiencies do not necessarily mean progress toward greater economies.

Coal Production

Series of indexes in the complete report indicate that anthracite as a source of energy is in a definite period of decline. Bituminous coal is seen to react readily to the trend of business activity, and the general decrease in its amount of production during the past five years reflects the results of competition by other fuels and of the greater efficiency of use of bituminous coal.

In the field of anthracite coal, in a drive for greater efficiency to enable it to hold its competitive place, mine operators are closing down high-cost mines and are concentrating on increased tonnage from fewer sources. This lowers overhead, improves the working time, and increases the output of employees without changes in tonnage rates; also breakers can be operated as large central units. During 1930 ten mines were closed in the northern field.

In addition to the competitive fuel encroachments previously mentioned, the bituminous-coal industry has been suffering from the demoralizing effect of overproduction since the World War. Strenuous efforts are being made by the operators to rehabilitate their industry through stabilization. The first problem is being met by mechanization of operations both above and below ground. Satisfactory progress along this line is being achieved. This activity is more notable for its effect on the production of a better product and for the attainment of lower overall costs than for its contribution to production volume. The problem of stabilization by cooperation to control resources, production, and price is fundamentally a difficult one. Among 7000 mines there are 6000 independent mine owners. Efforts at cooperation along sound economic lines would soon be in conflict with the Sherman Anti-Trust Law. Modification of this act, many mine operators believe, would be a distinct aid to the stabilization movement, while other owners are opposed to any alteration of the law, fearing such action would be an encouragement of Government regulation.

The suggestion has been made by certain powerful elements in the bituminous industry that the Government should buy the coal mines and operate them as a public utility.

The total production of by-product coke for the first seven months of 1931 declined 33 and 28 per cent from that for the same period in 1929 and 1930, respectively. This drastic curtailment in carbonization is due principally to a drop in industrial demand.

The statistics on beehive-coke production indicate clearly the extent to which the beehive ovens have been supplanted by by-product ovens. For the first seven months of 1931 only 3.9 per cent of the total coke produced was manufactured in beehive ovens. The figures indicate a temporary increase in beehive coke during the year 1929, but this is due not to a reversal of trend but to an overtaxing of installed by-product plants caused by the unprecedented demand for iron and steel during that year.

The 1930 output of fuel-briqueting plants was 1,028,865 net tons, a decrease of 15.1 per cent in tonnage from 1929.

Oil

The first six months in 1931 in the oil industry present an excellent illustration of the havoc which may be wrought by the law of supply and demand. Despite the greatest curtailment in production of both crude oil and refined products in some fields when compared with previous years, the promiscuous drilling of wells in other fields has lowered prices to levels never before experienced in the industry. This has occurred in spite of maintenance of domestic consumption comparable with that in 1930. The new field uncovered in east Texas is an example of the demoralizing influence which can be brought about when a single district is opened up without regard for crude-oil supplies, both above ground and potential. A spectacular feature was introduced into the oil situation by acts of the governors of Oklahoma and Texas in forcibly curtailing the production of oil.

The domestic consumption of gasoline for the first six months of this year was 191,505,000 bbl., an increase of 1.0 and 10 per cent over the same period in 1930 and 1929, respectively. Refiners curtailed their output to the extent that in mid-July stocks of gasoline at the plants were about 8,200,000 bbl. less than was the case at the same time in 1930. These facts not only demonstrate the comparative immunity of the retailing phase of the oil industry from the effects of depressed general business activity, but also the extent to which there is curtailment of refinery operation and the drawing upon of refined stocks. The troubles of the petroleum industry cannot be attributed to the present state of business activity, but to conditions within the industry itself. The total gasoline yield per barrel of crude oil increased from 39.6 per cent in 1929 to 42.0 per cent in 1930. This indicates the increased usage of cracking processes and improvements in the distillation of petroleum products. About mid-year the Associated Oil Co. at Avon, Calif., commenced operation of its new 10,000-bbl. tube-and-tank cracking unit, the largest in operation at present. A number of new features were incorporated in the unit's construction, among them the use of special safety devices.

New gasoline pipe lines are under construction as extensions to the Des Moines-to-Chicago gasoline line, and during the past year a 550-mile gasoline pipe line from Philadelphia to the Great Lakes has been completed.

Gas

The effect of the present business depression has been but slightly felt in the manufactured-gas industry, and available figures indicate that the decreases in industrial consumption have been offset by increases in domestic consumption. There has been an increased application of the mechanical grate in water-gas generators. The use of bunker oil as a substitute for gas oil in carbureted-water-gas sets has been successfully achieved on a full-plant scale for more than a year. A new steam-generating dry-quenching unit has been also placed on the market. It is designed for use in coal-gas plants where the quantity of coke produced per day is relatively small.

[1] The executive committee of the A.S.M.E. Fuels Division, whose annual progress report is here abstracted, consists of W. J. Wohlenberg, *Chairman*, A. D. Blake, *Secretary*, and C. P. Tolman, S. B. Ely, F. M. VanDeventer, R. A. Sherman. The original report was prepared by T. A. Mangelsdorf and A. H. Dickinson.

The use of gas in conjunction with silica-gel absorption units for air conditioning in buildings and homes has evoked considerable interest. A large bank building in Baltimore has such an installation.

The sale of natural gas for the first six months of the year showed a decline of 9.7 per cent from the sale during the same period in 1930, this decline being purely due to decreases in amounts sold to industrial plants. But the expansion of facilities for distributing natural gas from the centers of production continues to be nation-wide and during the early part of this year pipe-line projects of 9586 miles length were planned. The 1000-mile 24-in. line from the Texas Panhandle to Chicago is completed, and it is proposed to lay a second carrier of 30-in. size parallel to the first, to be extended to the New England states. For the year 1931 expenditures for pipe-line construction will be approximately $450,000,000, and the development of more extensive pipe lines seems assured because of the new gas resources continuously being found.

With large sources of supply from refinery gas and natural-gas gasoline, the liquefied-gas industry is expected to develop its wide potential market of small or isolated communities and of specialized uses to a greater extent than it has during the past five years. Early this year there were approximately 73 plants of the butane-air type in operation, and it is estimated that 50 more will be added before 1932. Heretofore the distribution of liquefied gases has been done in tank cars or containers, but in the future it is expected that pipe lines may be used economically. The 681-mile line running from Borger, Texas, to St. Louis is arranged so that natural-gas gasoline, butane, refinery gasolines, and possibly liquid propane may be carried. It is estimated that there are available daily from refinery and natural gases in this country a possible supply of 24 million gallons of butane and propane.

Power Generation

As a result of decrease of demand for industrial power the total amount of electrical energy generated by central power stations during the first seven months of this year is behind the amount produced during the same period in 1929 and 1930 to an amount less than 5 per cent, but the January–July production for 1931 is 17 per cent above that for 1927.

The average fuel consumption per kilowatt-hour should reach a new low this year in view of the fact that central stations are making every effort to obtain the highest possible thermal economies from existing equipment.

With respect to central-station design, the trend continues to fewer and larger pieces of equipment, operating at higher capacities per unit of size. Attempts are being made to improve the design of turbines operating at high temperatures and pressures to permit the attainment of high economy over a wider range of loads. The trend also is to operate the newer turbines at high capacity factors. The total outage factor for the year 1930 was 9.17 per cent, the lowest yet obtained.

Compared with the previous five years, the total of new orders for steel boilers during the first seven months in 1931 has been drastically curtailed. The trend in installations continues upward with respect to both temperatures and pressures. Where reheat cycles are employed, the trend is toward compact boilers with reheaters integral. Practice is about equally divided in the use of convection and steam types of reheater. During the year the A.S.M.E. Boiler Code Committee has announced the authorization of fusion welding of boiler drums.

The slag-type furnace has forged ahead over the dry-ash-removal type. The latest development of this type of ash-removal equipment consists in using a combination of vertical firing and slag-screen tubes covered with refractory material by means of which the heat generation per cubic foot of furnace volume and the furnace temperature are increased and a greater amount of ash is drawn off in the form of slag.

Significant trends are now to be observed in regard to the types of fuel consumed under boilers in public-utility electric stations. The amount of solid fuels and oil fired follows an indefinite trend, susceptible only to business activity, while the amount of natural gas consumed has increased markedly since 1927. At the end of June, 1931, statistics showed that coal consumption was down 6.6 per cent, fuel oil used was off 11.1 per cent, and natural gas consumed had increased 5.3 per cent over the first six months of 1930. The fact that natural gas possesses a three-to-one advantage over electricity as regards transmission costs gives rise to the possibility of power plants in the future becoming decentralized and established locally.

The sales of pulverized-fuel equipment, mechanical stokers, and oil burners have suffered considerably. There is a decided trend toward increased use of the unit system of firing.

One of the outstanding central stations placed in service this year is that of the pulverized-coal installation of the Virginia Public Service Co. at Bremo Bluff, Va. The plant is not outstanding as regards magnitude, but does have many unusual features; e.g., the 15,000-kw. turbines are the largest 3600-r.p.m. condensing units yet built in the United States. Use is made of rain-type, direct-contact extraction heaters which discharge to suitable pressure stages of a multi-stage condensate pump.

Renewed interest is being show in the Emmet mercury-vapor process, and designs have been made for the immediate construction of two 20,000-kw. mercury turbines. One is to be installed at the Kearny Station, Public Service Corporation of New Jersey, and the other at Schenectady.

The Champion Coated Paper Co.'s factory in Hamilton, Ohio, is the largest in the world to be supplied with energy from only one boiler and turbine. The former is the largest high-pressure and unit-fired boiler yet installed for industrial use. The pulverized-coal burners are the largest ever built, one having successfully burned 12,000 lb. of coal per hour. The new power-plant installation of the Waterbury Clock Co., Waterbury, Conn., contains a steam-generating unit in the inverted-pyramid furnace of which crushed coal is suspension-fired. Tests have shown that the lines or quality of coal has no measurable effect on efficiency or operation, so that fuel may be purchased on a strictly B.t.u. basis. In late July the new high-pressure unit at the River Rouge Plant of the Ford Motor Company went into operation The 110,000-kw. vertical compound turbine, the largest of its type, takes steam at 1250 lb. pressure from two double-set boilers operating at 1400 lb. pressure. Pulverized coal and blast-furnace gas are fired in the single furnace simultaneously. This installation is outstanding since the turbo-generator is the largest ever made for industrial use, and the largest to operate at high pressure, each generator unit being rated at 55,000 kw.

Industrial Fuel Utilization

The retrenchment of general business has had an especially marked effect upon the development of special processing and heat-treating industrial furnaces during the past year. In blast furnaces the control of the stream of materials and of molten metal is becoming increasingly automatic. In the cement industry there is a distinct tendency toward the use of longer and bigger kilns. Those approximately 365 to 375 ft. long are standard, and it is expected that some of 400 ft. length will be constructed. The reasons for increasing the kiln size are that there may be obtained a better preparation of raw materials up to the clinkering point by means of a longer burning or clinkering zone. In large-sized kilns there is better heat transmission from stack gases to raw materials, a greater possibility to use slurry-drying devices, and an appreciable reduction in dust losses.

Hydraulics[1]

A REVIEW of the progress made in hydraulics since the last annual report of the Hydraulic Division, although indicating no outstanding development in the several branches of hydraulics and failing to show any decided or radical change or improvement in the design of hydraulic equipment, discloses, nevertheless, a year of steady and very satisfactory progress in all sections of the industry. This being the second year of probably the worst depression in the history of the country, it is rather notable and decidedly satisfactory to observe that the hydraulic industry as a whole, and the electric light and power industry in particular, has shown a much lesser tendency toward retrenchment and a much greater willingness to continue in full force their long-time construction programs than any of the other primary businesses.

At such a time it is interesting and of value to survey briefly the progress made in hydraulics in the past two decades, thus affording a better understanding of the general trends and indicating more clearly the results obtained during the past year, which have been those of the steady application of such innovations and developments of the past few years as have been demonstrated to be correct by successful use, rather than the introduction of any new or radically different types of design or methods of operation.

Although the study of hydraulics dates back to ancient times and many of its fundamental laws were well enunciated years ago, its greatest development and most rapid progress in practical application has been made in the past twenty years. This intensive development has been coexistent with the growth and development of the hydroelectric power industry, which, notwithstanding the many deficiencies with which it is burdened by its numerous critics, has in its constant reduction of power costs afforded the primary basis for the tremendous growth of industry in this country during the present Machine Age, and the constant improvement in the standards of living. Aside from that department of hydraulics concerned primarily with the problem of rivers and harbors and developments in marine practice, substantially 90 per cent of its study and application is concerned with hydroelectric power development.

Increase in Capacity and Efficiency of Hydraulic Prime Movers

In the past two decades, the capacity of hydraulic prime movers has increased from units of 5000–10,000 hp. to those of 90,000–100,000 hp., with the trend still toward fewer units of larger capacity in each new development. The limiting feature as to size appears to be that of transportation facilities, with a possible secondary limitation, as regards high-head reaction turbines, imposed by the present state of foundry practice in the production of large turbine castings. A still further limitation appears possible in medium-head developments due to the limiting thickness in which steel-plate penstocks can be satisfactorily field-riveted. In a large development now in progress in the West, where heads around 525 ft. are to be utilized, it appears that the maximum diameter of penstock possible at the turbine will be 11 ft.—this requiring, with reasonable factors of safety and moderate pressure rises, a plate thickness of $1^3/_4$ in. It is interesting to note, as regards capacity trends, that the city of Seattle is installing in its Diabolo powerhouse units of slightly over 90,000 hp., and that the engineers responsible for the design of the Hoover Dam powerhouse are seriously considering the adoption of units having a maximum output of 125,000 hp.

During this 20-year period there has been a very remarkable improvement in the efficiencies obtainable from hydraulic turbines, and also marked progress in the efficient design of the entire water-conduit system from forebay to afterbay and including flumes, spillways, etc. In the reaction-turbine field, efficiencies have improved from around 50–75 per cent to between 92 and 94 per cent at the present time. There were probably a few exceptions where reaction-turbine efficiencies ran above those given for 1910, but most of the units installed at that time were within that range. The rather extreme and unfortunate competition existing at that time between manufacturers resulted in very optimistic efficiency claims which were rarely checked by field test, and where made, such tests at that time were far from accurate, being generally based on doubtful assumptions and the use of coefficients which we now know were incorrect. Frequently the manufacturer was given the benefit of a considerable doubt, and in such cases quite remarkable efficiencies were the result. In the impulse-turbine field, efficiencies have improved from around 55–70 per cent in 1910 to between 85 and 87 per cent at the present time. The advance has not been as great in this field as in that of the reaction unit, and it is believed that there is more intensive experimental laboratory investigation now in progress on the part of impulse-turbine manufacturers than ever before. In the past year there have been a number of reaction-turbine field tests indicating efficiencies between 93 and 94 per cent, and two notable field tests of impulse turbines in each of which efficiencies between 86 and 87 per cent were obtained with very flat curves, the efficiencies being above 85 per cent from well below half-load to maximum output.

Model Testing and Laboratory Investigation

This quite remarkable improvement in the efficiencies of hydraulic prime movers and also of water conduits, valves, etc., has been especially apparent in the past few years, and it has been encouraged and intensified by the constantly increasing interest in, and the remarkably extending use of, laboratory investigation and model testing both on the part of the electric light and power industry and the manufacturer. One of the most encouraging signs of the times, and a decidedly major trend in the industry, is the energetic manner in which the power companies and the manufacturers of hydraulic equipment are cooperating in the investigation and solution of the many problems involved in the improvement of the overall efficiency of hydraulic power development. The past year has seen a more intensive effort and a broader scope in such laboratory work than ever before. The Hydraulic Division has endeavored to initiate and stimulate an increasing use of laboratory study and model investigation, and this is considered to be a worthy object of major effort on the part of its membership during the coming year.

This laboratory investigation is being carried on not only by a considerable number of the forward-looking power companies and equipment manufacturers, but by many of the more prominent technical colleges and a number of commercial laboratories. Most of these laboratories and the very valuable work they have done are well known to the profession. A few notable cases of such laboratory work illustrating the wide variety and value of model-test work undertaken during the past year are: The investigation of modern high-speed turbine runners, both of the Francis and propeller type, with regard to conditions of design and setting as affecting pitting of both runner and draft-tube

[1] The executive committee of the A.S.M.E. Hydraulic Division, whose annual progress report is here presented, consists of Everett M. Breed, *Chairman*, Carroll F. Merriam, *Secretary*, and Ely C. Hutchinson, L. F. Moody, Byron E. White, D. J. McCormack. The original report was prepared by Everett M. Breed.

liner, by the laboratory of the Shawinigan Water & Power Company recently established at Shawinigan Falls, Quebec; the investigation of several features of turbine design, and in particular the testing of model runners and draft tubes to insure most advantageous design for the turbines to be installed at the Safe Harbor Power Development, by the laboratory of the Pennsylvania Water & Power Company installed last year at Holtwood, Pa.; the investigation of most economic design of flumes, canals, forebays, spillways, etc., at the Alden Laboratory at Worcester Polytechnic Institute; and the investigation of most efficient design of scroll cases, speed rings, draft tubes, etc., for the Alabama Power Company by Allied Engineers, Inc., at their Birmingham laboratory. This latter series of investigations—a very fine example of the thoroughness of such model testing—was very completely reported in a paper by Ira A. Winter at the Semi-Annual Meeting of the Hydraulic Division in April of this year. Of major interest to the members of the Hydraulic Division in this connection is the successful outcome of the 12-year fight for a national hydraulic laboratory. As a result of the patient effort, self-sacrifice, and energy of a considerable number of leading mechanical and civil engineers, a bill was finally passed and signed by the President on May 14, 1930. Plans were completed in March of this year, and it is expected that the laboratory will be ready for operation in the latter part of 1932.

This question of model testing and laboratory investigation, in its relation to the continued vigorous growth of the hydraulic industry, cannot be overemphasized and should be considered as a major objective of interest and for stimulation by the Hydraulic Division for the coming year. It has the most direct bearing on, and is of prime importance in, that constantly agitated question of hydro vs. steam. A superficial glance at this problem leads the observer to the conclusion that with the hydraulic prime mover operating at around 94 per cent efficiency, there is very little chance for further improvement in the hydro development. That such is not the case can be readily appreciated by a study of the improvement already effected in the efficiency of waterways, flumes, forebays, and the inlet sections of penstocks, as well as of the reduction in capital investment in such structures and in the various types of dams, due to model testing and investigations. There is still very much of an open road before the hydraulic engineer in his efforts to reduce the true cost of hydro kilowatt-hours.

Improvement in Speed and Reliability

Along with the increase in size and improvement in efficiencies noted during the 20-year period, has come an improvement in speed and in reliability. The very considerable improvement in reliability has been due in part to the increase in size of units, but is largely a result of the very complete cooperation between the builder and user of hydraulic equipment. As a result, the reliability factor of hydraulic equipment as shown by recent reports of the N.E.L.A. is very much above that of steam-power equipment. The improvement in the ability of turbine manufacturers to design units capable of operating efficiently and with high reliability at the higher speeds is an economic result of the keen competition between manufacturers. Naturally this endeavor to produce units of higher speed with consequent reduction in first cost of turbine and generator, as also of the power house and substructure, has been most intensive in the low-head field where the turbines are inherently large, heavy, and of slow speed. The improvement has been very pronounced, especially during the last few years following the development of the propeller-type runner of both the fixed- and movable-blade designs. Some rather notable installations of this latter type of turbine have been made during the past year. Constant improvement is being made in the range of heads under which they may be operated, and units of the propeller type are now contemplated for use under a head of 85 ft.

It is interesting to note that notwithstanding the widespread propaganda on the part of certain trade associations and in the public press in favor of steam power during the past decade, the ratio today of the total amount of hydro power developed (12,000,000 hp.) to the total amount of steam power (30,000,000 hp.) is practically the same as it was ten years ago. It is probably true that water-power development would hold a still higher relative position were it not the object of political controversies based on the false argument that conservation of our water resources depends on their being withheld from development. Steam-power-plant engineers deserve great credit for the remarkable advances that have been made in the past few years in the overall efficiencies of steam-power generation, but it should not be overlooked that these advances have been made at the sacrifice of simplicity and reliability. Carefully prepared statistics covering outages over the past few years on the part of the large operating companies have definitely indicated that hydro power units have a much higher reliability or endurance factor than steam units, and that the upkeep charges on hydro units are only a small fraction of those of steam.

Combined Hydro and Steam Power

The availability of extremely cheap fuels in certain sections of the country, such as oil and natural gas in southern California, undoubtedly gives the steam plant an important advantage, but it should be realized that they are a local and probably more or less temporary condition and should not unduly affect general conclusions. In addition to the improvement in efficiencies of hydro prime movers and of water conduits, etc., a great deal of study has been given in the last few years to the improvement of overall efficiency of the plant as a whole where there are several units installed. This effort has been quite generously rewarded, and during the past year a number of large plants have been in operation under a load-control system designed to automatically divide the total power demand on the plant in the most advantageous way among the several units. Improvements in plant efficiencies of 8 to 10 per cent have been obtained. All of the factors affecting the division of hydro and steam power in any certain locality are quite easily obtainable, and it is now generally recognized that even in territory where fuel costs are extremely low a proper division of hydro and steam will produce cheaper power than can be obtained from steam alone. Where hydro power is not available in any considerable amount, the desirability of using pumped-storage power is worthy of investigation, and a great deal of thought and research is being given to this type of development at the present time. The use of this type of plant to take care of peak-load requirements on a system has been demonstrated in Europe during the past two years as being of considerable economic advantage, and an increasing amount of laboratory investigation is being undertaken at the present time to perfect this system of power. Encouraging results have already been obtained, and one of the large eastern manufacturers has developed a combination pump-turbine unit which in a model test in the laboratory has shown an efficiency of over 89 per cent operating as a turbine and over 85 per cent when pumping.

Progress in Valve Equipment

Along with the steady growth in size and improvement in design of hydraulic-turbine equipment there has been a similar progress in valve equipment. Last year saw the installation of the largest butterfly valves in the world—27 ft. in diameter under 40 ft. head, at Conowingo—and this year has seen the installation of the largest medium-head butterfly valve—17 ft. in diameter under 180-ft. head, at the Ariel development of the Inland Power &

Light Company in Washington. Aside from this question of size, the only outstanding development in valve work is that of the definite adoption in several notable installations of butterfly valves for free-discharge service under medium heads. During the year three 72-in. free-discharge-type butterfly valves have been installed by the city of Seattle for operation under 180 ft. head at the Diabolo Dam, and two 78-in. free-discharge butterfly valves for operation under 300 ft. head at the Salt Springs Dam of the Pacific Gas & Electric Company.

Progress in the design and operation of pumping equipment and advances due to laboratory investigation covering such equipment in the past year have been along the same lines as those already outlined in regard to turbines. The stimulus for such advance has been largely economic, the progress being in the direction of further reduction in weight and size for the same duty; higher speeds in low-head pumping equipment; and improved efficiencies, especially on the fringes of the centrifugal-pumping field. Especially noticeable has been the improvement in efficiencies in the high-head field, where, in capacities of 50 to 100 gal. per min. against 1000 ft. head or more, efficiencies of 55 to 65 per cent have been obtained, and in larger sizes, 400 to 500 gal. per min. at 3500 to 4000 ft., above 70 per cent. Considerable advance and improvement has been made in the application of centrifugal pumping to oil-pipe-line duty, and that field, so long dominated by reciprocating equipment, is being encroached upon by the manufacturer of centrifugal equipment. The improvement of pumping equipment for handling corrosive fluids has shown great progress, largely due to the advance made in the production of alloy steels, especially the stainless chrome steels.

Satisfactory progress has quite generally been made in the other branches of hydraulics. The expansion of the pipe-line business and the increased adoption of higher pressures in hydraulic shop equipment such as presses, forges, testing equipment, etc., has resulted in a steady improvement in the design of various types of valves. The use of hydraulic presses rather than power-driven presses appears to be on the increase in many classes of manufacture. This is especially noticeable in the wallboard industry, and to a considerable extent in the rubber industry. The tendency is toward the self-contained type of presses and power plants, which eliminates accumulators and pipe lines, thus reducing upkeep costs and otherwise effecting a considerable economy.

It is hoped that the foregoing brief review of progress in the more distinctive fields of hydraulic endeavor will give the members of the Hydraulic Division an overall picture of the industry. No attempt has been made to cover such subjects as dams, pipe lines, generators, etc., as there has been no particularly outstanding development in the design of these structures and they are more properly covered by the civil, electrical, and other branches of engineering.

Iron and Steel Industry[1]

THE period covered by this report is the year ending September 1, 1931, or at the low point in ingot production since the year 1921, showing an operating rate in August of 31.13 per cent of the industry's estimated capacity as of December, 1930. The review, however is not economic in character, but shows that progress has been made notwithstanding the depression, and that the steel industry is made up of men who have the courage of their convictions and confidence in the future. Large expenditures have been made by all companies. Improvements have been installed that will better the quality of the product and take care of future demands for some time to come.

Metallurgical Progress

Very interesting results in the attempt to solve the manganese problem in the manufacture of steel have been reported by the War Department in experiments carried out at Watertown Arsenal, where gun steel of very satisfactory grade is being made by replacing manganese with zirconium.

Several noteworthy installations of photoelectric or vacuum-tube control in steel-plant operation have been made. Among these are the operation of soaking-pit covers, the control of tension in the drawing of wire, and various operations in pipe-facing machines. Mention should also be made of an improved electrically controlled automatic "screw-down" for plate-mill operations.

The application of tungsten carbide dies for wire drawing has continued to give very promising results. One authority states that "perhaps at last wire drawing is on the threshold of becoming modern."

A new material for metal cutting, sintered tantalum carbide, termed "ramet," is now available commercially.

[1] The executive committee of the A.S.M.E. Iron and Steel Division, whose annual progress report is here abstracted, consists of W. Trinks, *Chairman*, J. H. Hitchcock, *Secretary*, W. W. Macon, A. G. McKee, A. J. Boynton, and W. A. James. The original report was prepared by H. A. Deuel.

Testing

Methods for the "non-destructive" testing of metals are of decided interest to engineers. The use of "gamma rays" from radium or other radioactive materials has been developed by the Naval Research Laboratory as an extension and supplement to X-ray examination. Reports issued by the Navy Department of the detection of faulty stern-post castings in recently constructed naval vessels have served to show the practical utility of the method.

Fatigue or endurance testing of metals at low temperature has given results indicating that metals are no more prone to fatigue or failure at low temperatures than at normal temperatures. The lowered resistance to shock appears to be the chief source of concern.

The method of detecting flaws by the magnetic dusting method has been greatly improved and simplified, so that it is only necessary to sprinkle the iron dust on the magnetized piece.

Furnaces

The increase in the use of high-frequency induction furnaces in the steel industry is believed to be very significant. Furnaces with melting capacities up to 4 tons have been installed.

Heat Treatment

Experimental work on the heat treatment of full-sized rails has continued, and a process for this which is claimed to be commercially feasible has been developed.

A method for the development of the necessary high-strength properties of certain austenitic steels for commercial purposes by means of cold treatment has been announced. This is applied to the article in its final polished condition and would appear to have many useful applications. Mention is made of the prize-winning paper by Davenport and Bain on the decomposition of austenite which has so greatly clarified our ideas of what occurs in heat treatment.

Materials for High-Temperature Service

Materials for high-temperature service, together with the development of suitable test methods for their evaluation, have continued to demand a great deal of attention. Noteworthy in this respect is a symposium on the subject sponsored jointly by The American Society of Mechanical Engineers and the American Society for Testing Materials.

The study of means for remedying the embrittlement of the widely used "18–8" austenitic steel for high-temperature service has continued. Various indications have been developed, but no fully demonstrated solution of the problem has yet been met.

New Materials

The field of usefulness of the stainless type of steel has been extended by the development of "stainless clad" steel.

Nickel-clad steel is now on the market, and its use for the construction of vats, tanks, and other containers which must resist corrosion appears very promising.

Progress is noted in the nitriding process for the surface hardening of certain grades of steel, and definite progress is reported in the manufacture and application of stainless steels.

Sheet Mills

The irregular and limited operation of steel plants has not been conducive to material progress in steel-making methods. Efforts generally have been directed to utilizing existing equipment to the best advantage, particularly as regards blast furnaces, open-hearth plants, and heavier lines of rolling equipment.

A notable exception to the lack of building activity in steel-making lines is that relating to wide-strip rolling. The wide-plate and strip mill of the Illinois Steel Company was completed and put in operation last spring, and construction of wide-strip mills is now under way for the Inland Steel Company, the Otis Steel Company, and the Allegheny Steel Company.

The existing wide-strip mills of the American Rolling Mill Company, American Sheet and Tin Plate Company, Weirton Steel Company, Wheeling Steel Corporation, and Republic Iron and Steel Company have made progress in the application of their products to uses formerly satisfied by products of the standard-type sheet mill.

The employment of the wide-strip-mill products has been furthered by the utilization of cold-reduction mills for rolling light gages and through the use of improved continuous furnaces and auxiliary equipment on standard-type sheet mills.

The wide-strip mill has displaced to a considerable extent light-plate, jobbing, and sheet-mill products as formerly manufactured, due to some cost advantage. The sheet mills have secured a new lease on life through the employment of the continuous pair and pack-heating furnaces recently developed, together with the application of mechanical tables for handling bars and packs during the process of rolling. Other time- and labor-saving devices, such as mechanical roll polishers and automatic shears, are being installed. Through the installation and use of this equipment the old-style sheet mill is able to reduce costs somewhat. The old-style sheet mill so equipped has the advantage of lower fixed charges and flexibility in handling small orders compared with the large tonnage necessary in order to operate profitably a continuous strip mill. In some instances strip from the wide-strip mill is used instead of sheet bar through these continuous furnaces.

It has been found that the rolling of sheet bar in widths of from 10 in. to 16 in., instead of the standard 8-in. bar, is an important step in meeting the competition of the wide-strip products, the wider bar being well adapted to use in the improved pack furnaces with the tables mentioned above.

A number of mills capable of rolling sheets up to 60 in. wide and 14 gage in thickness have been installed during the past year and are now being placed in operation. What is probably the largest plate mill in the world was also started this year.

Increased speeds and drafts have been made in the rolling of flat material, but probably the greatest contribution in addition to the rugged and precision-like machinery is the electrical-control contribution which makes it possible to synchronize properly the speeds of the succeeding stands of continuous mills.

While progress has been made this year in cold rolling, by continuous methods, the strip made on the hot mills, the practicability of cold rolling has not been definitely established. Continuous cold mills are now operating and reducing material from 14 and 16 gage hot strip to 31 gage by one pass through approximately 6 cold-roll stands. That this method has not been introduced to any greater extent indicates that it has not effected the economies hoped for.

To offset the developments in strip rolling and permit sheet and tin mills to compete, it has been necessary to devise new ways of handling the material in the conventional sheet and tin mill. One large company has pioneered and led the way in the development and introduction of equipment for this purpose. Continuous heating furnaces known as the "radiant gap" type have been developed by them for the heating of pairs and sheet packs. Mechanical-handling equipment on the roller's as well as the catcher's side of the mill has been developed and electrical equipment applied which will synchronize the operation and make the mechanical equipment function automatically until the sheets reach their proper length.

The introduction of this equipment has not only eliminated the arduous labor involved in sheet and tin-plate rolling, but has permitted about three times the production from a conventional sheet mill as compared with the former hand-rolling system.

In the past, sheet-mill practice was dictated largely by the physical ability of the roller or other men on the crew to do certain work. Now that mechanical means and new methods of rolling have been developed, it is quite likely that there will be new methods and practices adopted for the production of sheet and tin plate, and that a more thorough cooperation will exist between the strip producers and the sheet and tin mills, as it is quite likely that material produced by the strip mills will be used in place of bar for finishing to light gages in the tin-plate industry. Many plants are now reconstructing their bar mills to permit the rolling of wide bar, in some cases up to 24 in. wide, which after all is an approximation of strip.

Tubes

Outstanding among the developments in recent years in the steel business are those relating to the manufacture of tubes, large and small in diameter, and particularly with thin walls in almost all sizes. Specifications with more exacting tolerances as to diameter, wall thickness, straightness, and physical qualities of steel have made the task of the tubular-good manufacturers more difficult.

A review of the patent specifications, the reading of trade magazines, and current information coming from various sources reveal the flood of ideas as to how pipe should or can be made. Many ideas reach the patent stage, which is as far as some of them will travel. The methods vary from the many types of straight-seam electric (fusion, flash, resistance, etc., etc.) and autogenous gas straight welding equipments to spiral (why called spiral when technically helical?) fusion and even resistance welding, and the comparatively new methods of seamless manufacture actually in successful operation. It is proposed to develop the process, tried to a very limited extent in Germany, of extruding steel tubes in small diameters so as to cover a large range in diameters and with any desired wall thickness. Some of the

processes proposed are outside the realm of practicability, and others, while possible of some degree of success, are certainly outside the limits of commercial practicability.

A number of propositions made that plan to weld long pipe lines in situ have commercial possibilities, one even going to the extent of proposing that the pipe-manufacturing equipment proceed along the path of the proposed line, dropping the pipe into the trench behind it. Some of these schemes would involve the use of very heavy coils of skelp or plates. No one can say that some sort of project of the kind will not be used since the plan is not entirely new, having been used in a limited way, but the idea certainly seems fantastic to the manufacturer, whose worries are in satisfying customers' inspectors as to appearance, testing, tolerances, and steel quality.

Meanwhile, it should be expected that important developments will be commercially realized along the line of all methods of manufacture of seamless pipe which start with piercing of the round billet. It cannot be denied that seamless products possess some superior qualities not otherwise obtainable, as is evidenced by the many kinds of service where other than seamless tubes are not accepted or even permissible. The engineers and operators who have this problem to face fully realize what is ahead of them, and encouraged by the continued advances made in steel quality will without doubt succeed in developing ways and means to the ends sought.

Miscellaneous

The five-year program of the U. S. Bureau of Mines, Carnegie Institute of Technology, and the Metallurgical Advisory Board, will end December 31. This work has been concentrated on the fundamentals of still making, and the application of these metallurgical fundamentals primarily to the present open-hearth process.

In this work it has been necessary to study new methods of determining what is in steel, and one of the best-developed is the electrolytic method for determining inclusions in plain-carbon steels. This method has been taken up quite rapidly by the industry, and a large number of steel makers and consumers are using it in their investigational and routine work. In one plant, at least, the method is being used as a control for the disposition of steel ingots. This is probably the first real test, aside from the ordinary chemical analysis, which has been devised to show where a steel ingot should go.

Another important development along fundamental lines has been the study of slags resulting from the deoxidation of steel and the speed with which slag particles may be eliminated from steel. This study has resulted in the development of a new manganese-silicon alloy which has been used quite extensively in experimental work with most promising results, and which has been put into regular practice in at least one large steel plant. Special heats made with this alloy are undergoing critical tests in consumers' laboratories at the present time.

Combustion control is still developing rapidly throughout the country. There still seems to be a need for the proper design of open-hearth furnaces for different fuels. Operators who have changed from one fuel to another in the same furnace have found it necessary to make extensive alterations in furnaces in order to get satisfactory results with the new fuel, but invariably these changes come only after poor results have been obtained on the unchanged furnace. With the many types of fuels being used in this country, it would seem that there is very little information which is available to the steelmaker for use in the design of open-hearth furnaces for many types of fuels.

Machine-Shop Practice[1]

THE present report does not truly picture the progress in the machine-tool industry during the current year. The reason for this is that practically every manufacturer is engaged in large-scale redesign of his products, but is waiting for the coming of better markets and is not making public the improvements he has effected. Further, about the only important buying being done at the present time is by the large, well-financed firms engaged in continuous production. There is a tendency for those engaged in such production to use special machinery, about which again little is said.

The effects of the use of new cutting materials, such as tungsten carbide and the lately introduced tantalum carbide, continue to be felt. Milling with tungsten carbide cutters has made great strides this year, chiefly, however, in the case of structural materials other than steel. The introduction of tantalum carbide and tantalum-rich tungsten carbide apparently indicates that steels will shortly be also included in this list. A marked advance is also to be noted in the application of tungsten carbide to tools other than milling cutters, including counterbores, circular forming tools, cutting-off tools, drills, and reamers.

As regards special machinery, the following may be mentioned. Large hob- and cutter-grinding machines have been built to take hobs, milling cutters, etc. up to 12 in. in diameter and 12 in. long, with automatic feeds in all directions. A special double-spindle drilling machine has been built for locomotive trucks and other large steel castings. In this case a combination of longitudinal and swiveling movements is employed. Likewise a line of hydraulically fed multiple-spindle drilling machines of the slide type have been brought out, on which either adjustable-spindle or fixed-center heads can be used interchangeably. The feeding pressures range from 5000 to 50,000 lb., and the turning hp. applied to the tools from 5 to 50 hp.

Welding methods, especially arc welding, have made great strides in their application. Machine frames for a varied line of equipment are now arc welded instead of having cast members. In the assembly of machine parts, screws, bolts, and rivets have also been replaced to an ever-increasing extent by the welding process. New electrodes adapted to welding jobs that formerly were considered extremely difficult or impossible have been developed. Thus one company is now building a 48-in. × 48-in. × 11-ft. planer on which the bed, table, uprights, and tie beams are made of welded steel instead of castings.

An interesting special machine that may be mentioned is a 72-in. boring and turning mill designed for the General Electric Company, to be used in the application of tungsten carbide tools to the work in their plant. This machine embodies several novel features, including cutting speeds from 20 to 1000 ft. per min., and is driven by motors aggregating 250 hp.

Advance in Milling-Machine Design

The advance in milling-machine design and in milling practice during the present year has been very great, due largely to the introduction of tungsten carbide tools. While reference has

[1] The executive committee of the A.S.M.E. Machine Shop Practice Division, whose annual progress report is here abstracted, consists of Frank C. Spencer, *Chairman*, Carlos deZafra, *Secretary*, W. W. Tangeman, W. J. Peets, Coleman Sellers, 3rd, and Benjamin P. Graves. The original report was prepared by Carlos deZafra.

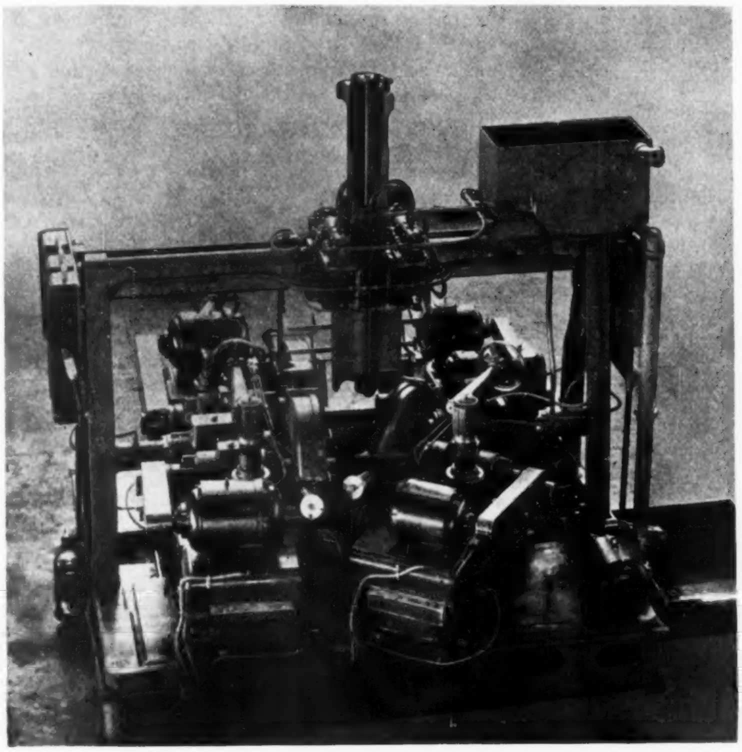

Fig. 1 Grinding Machine for Grinding Four Surfaces Simultaneously

already been made to this matter, it may nevertheless be added that to utilize properly milling cutters tipped with tungsten and tantalum carbide, it is necessary that milling machines have a much greater rigidity, a greatly increased speed range, and a broader feed range. Neither the speed range nor the feed range heretofore used has been adequate. As to rigidity, this means not only a heavier frame but also heavier and better-mounted spindles, shorter and better shafts, better-designed gear trains, and greater use of anti-friction bearings.

Machines are now on the market having the required rigidity for tungsten carbide operation, and have spindle speeds with a range as high as 100 to 1, giving speeds from 15 to 1500 r.p.m., and a range of feeds of 240 to 1, giving feeds from $^1/_4$ in. to 60 in. per min. Other machines of the production type have spindle speeds up to 1000 r.p.m. and feeds up to 100 in. per min. A two-piece arbor support has been introduced, making it possible to remove the arbor from the machine with all its cutters intact, and thus saving a vast amount of set-up time. On production jobs, duplicate gangs of cutters and arbors can be used so that one set can be in operation while the other is being ground, reducing the down time of the machine to the very minimum. In manufacturing jobs having small-lot production, the cutters may be placed on an arbor and adjusted correctly on the bench while the machine is in operation on other work, thus greatly reducing the length of time the machine has to be stopped for set-up. On complicated gangs of cutters, the arbor set-up need not be broken down each time the job is run, but the arbor, with all cutters intact, may be stored in the toolroom with the milling fixtures until again required.

A universal milling machine has been introduced having a dividing head which, together with its driving mechanism for spiral cutting, marks what is probably the only important advance made in dividing heads and spiral drive mechanism in over fifty years. The spindle of the dividing head is exceptionally large in diameter, and is mounted on preloaded ball bearings to prevent spindle float and insure greater accuracy and much greater permanence to that accuracy. The spindle is driven by a hypoid bevel gear having a 5-to-1 ratio instead of the customary 40-to-1, thus reducing the indexing time to one-eighth its previous value. The dividing head indexes all consecutive numbers up to 500, and has change gears and driving mechanism to cut over 40,000 different leads from as fine as 38 threads per inch up to a lead of 240 ft. per turn of the spindle. The dividing head can be set with the spindle horizontal with the table or at right angles thereto, and can be driven for rotary milling without table advance.

Grinding Machines

In the field of grinding machines a precision grinding machine has been designed for grinding four surfaces simultaneously on the axle shaft of a certain make of car. Formerly each operation was handled by a separate operator on an independent machine. In this case all four operations are combined on one machine, and in addition, automatic loading and unloading facilities are embodied as an integral part of the design. The feature of flexibility to take care of reasonable

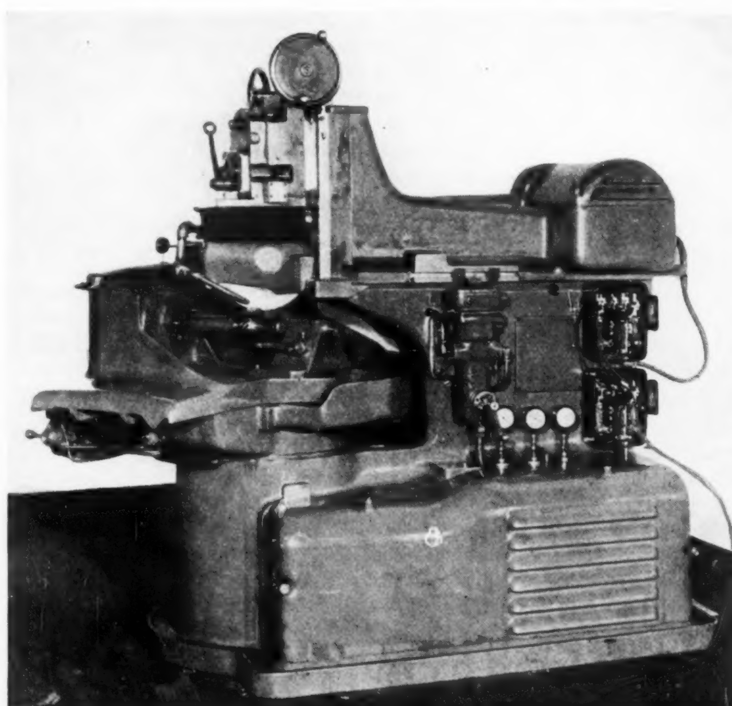

Fig. 2 Helical-Gear Grinder

changes in the product is obtained by mounting the grinding-wheel heads on a flat base, so arranged that they can be repositioned anywhere within the length capacity of the grinding machine.

Among the general developments may be mentioned progress in methods of analyzing vibrations. For this purpose portable balancing equipment quite different from the standard balancing machines has become available, as well as lighting equipment therefor which makes parts rotating at high speeds appear as if they were standing still. New applications of the photoelectric cell have been made in the metal-working field, and new electrolytic processes have been developed for removing scale and rust from steel parts.

As regards the general tendencies in machine-tool design, efforts are being directed toward improving the quality and accuracy of the product, and particularly toward reducing the time required to fabricate. There may be a certain element of incongruity in introducing labor-saving devices at a time of extensive unemployment, but it is felt that conservation of labor is necessary for future progress.

Improvement in Processes

The report points out that this can be achieved not only by improvement in machinery, but also by improvement in processes, such as the substitution of welding for foundry casting, the use of die castings—calling for the minimum of machine operations, and particularly improved forging, coining, and other hot-forming processes. Already wide-awake manufacturers using forged units in large quantities are beginning to make their forgings so close to the finished size that they have been able to eliminate entirely the intermediate turning operations, simply passing the piece direct to the grinding machine for sizing. Realizing the additional burden which this throws upon the grinding machine in the way of increased stock removal, the grinding-machine manufacturers have consistently increased the power and metal-removal capacity of their machines, while manufacturers of grinding wheels have redoubled their efforts to make available cutting tools for the grinding machines which will accomplish this higher rate of metal removal without burdening the process with an increased tooling cost.

The keynote to the current thought on this subject was very clearly expressed at the spring meeting of the S.A.E. in Detroit this year, in a paper presented by representative engineers of the automotive industry. While the thoughts expressed in this paper were not entirely new, they represented the first attempt to put down definitely in black and white the specific requirements of the highest production mechanical-engineering industry in existence. These engineers stressed the need for high-production, machine-tool equipment with sufficient flexibility in the design to accommodate reasonable changes in the users' product, and this thought has underlain much of the design work of the past twelve months.

Progress in centerless grinding is illustrated by a machine arranged to grind four diameters simultaneously along the entire length of a four-cylinder engine camshaft. During the past year this process has also been extended to include the grinding of such articles as bowling balls, billiard balls, and spherical glass valves. It has been also found possible by the application of a cam control on the work-supporting member to grind the reliefs which have become a feature on most of the modern automobile-engine pistons.

In the grinding field may also be noticed a new tool for boring and grinding locomotive cylinders, as well as its tool-carrying head. One of the features of this machine is the correct centering method provided.

The tendency to drive cutting tools at their maximum efficiency is illustrated in a new milling machine which incorporates twelve speeds ranging up to 1500 r.p.m., and nine rates of feed. To reduce machine-handling time the twelve speeds are controlled by a single lever, which is also the method of controlling the rates of feed. The same company that manufactures this milling machine also makes a radial drill in which eighteen rates of feed are provided with a speed range up to 1850 r.p.m. All speed and feed changes are effected in the head and controlled by levers. The head is mounted on a roller-bearing gib, and the arm way on which the rollers bear has a hardened steel surface, a feature which is already fairly popular on other machine tools, particularly lathes and turret machines.

Fig. 2 shows a helical-gear grinder of the semi-automatic type for grinding the contours of the gear teeth in order to eliminate distortion due to hardening. It is claimed that the cost of this grinding operation after hardening is about the same as that of finished machining before hardening, but the machine produces gear transmissions which are claimed to be very silent.

The same company has built a 26-in. hydraulic surface grinder for use where the table has to be reciprocated at very high speeds, which would be impractical with mechanical clutches. It is claimed that in addition to increased production there is also a substantial saving in the cost of grinding wheels, as harder wheels can be used without any burning tendency, and therefore more pieces produced per wheel than was possible with the slower reciprocating table speeds.

Industrial Management[1]

MANAGEMENT has been placed on trial throughout the past year. It is not a difficult matter to apply the principles of management in times when business is prosperous, as in all probability any fairly well-conceived scheme of management will operate then with an acceptable degree of success. Years like 1931, however, put all such principles and schemes to the crucial test, and only those will survive which have proved under such conditions to be economically and ethically sound.

As far as any one can hope to see at the present moment, management, in its many aspects, has come to the forefront and provided many industrial executives with practices and technique which on the whole have made it possible for them to maintain a satisfactory financial condition in the face of reduced operating schedules, to keep inventories in a liquid condition, and to mitigate the effects of the business depression on employment.

General Economic Aspects of 1931

The thoughts of the whole world have centered, as never before, on the management of industry, agriculture, finance, and commerce. How to market, how to control production, and how to stabilize employment are questions for which answers have been attempted by thousands, and with nearly as many variations.

Thus, in the year 1931 we are in the midst of the most serious economic condition in our history, and neither its causes nor its remedies have been sufficiently identified or understood so that

[1] The executive committee of the A.S.M.E. Management Division, whose annual progress report is here abstracted, consists of William B. Ferguson, *Chairman*, George W. Kelsey, *Secretary*, and George E. Hagemann, Charles W. Lytle, Fairfield E. Raymond, John W. Nickerson.

a well-defined, widespread program of present relief or future prevention can be recorded. Years of reckless and planless expansion, together with much self-satisfied business and financial indulgence, accompanied various conditions which brought an inflated market to explosion two years ago.

At that moment of collapse, this country seemed to be in possession of all the material things and conditions which an opulent people could desire. There was no lack of money, no lack of raw material, basic supplies, productive capacity, or labor willing to work. At that moment, however, a great fear gripped our entire system of production and consumption; and we became afflicted with a partial paralysis and complete lack of balance. Thus, through 1930 and still more through 1931, we have seen on the one hand increasing millions desiring work which was not made available, and on the other hand in many cases an actually increasing purchasing power for those whose employment still existed but who through fear of its curtailment refused to demand and purchase those things which would make the higher standard of living for themselves and which would open up opportunities of work for their less fortunate fellows.

Marketing

Much depends, in the immediate future, upon the wisdom and ability shown by industry in marketing its products if business is soon to be placed on the road to recovery, if any lasting benefits are to be derived, and if the full force of the potential purchasing power of this country is once again to be realized.

The field of marketing is now in the greatest need of sound common sense and engineering skill. A few simple principles seem to be guiding the most progressive marketing policies today. The demand for useful products, cannot be forced into being. Industries are learning the fallacy of running blindly to capacity in the face of an unwilling market. It is being seen that it is necessary to embody in the product such essence of quality as will speak for itself, and that it is necessary to deliver with the product such a degree of helpful service as to make its acceptance unquestioned.

In many cases, careful analyses of geographic sales periods are turning losses into profits by the relinquishment of areas where excessive sales expense has failed to bring its return. Again, there is coming a clearer recognition of the necessity of dealing with greater judgment with different classes of consumers. Products are being selected to meet the demands of those who need the least in price and quality and of those who need the most.

It has been recently recognized, both in private investigations and by governmental analysis, that it is very nearly universal in industry today to find that approximately 80 per cent of the volume of production exists on approximately 20 per cent of the number of products in the line; and it is probably being more clearly seen that the overhead expense which should be allocated to the large number of products which constitute the small volume is also making them prohibitive of production and marketing.

Production Control

Great upsets in the markets of the world, and consequently the added complexities of the marketing problem, have given rise to increased effort to develop production control. It is doubtful if very many companies have actually exercised a great deal of production control, or at least could be honestly highly satisfied with their control. In fact, further progress in production control awaits progress in the field of marketing and a more thorough understanding of the problems of distribution.

The Employment Situation

The year 1931 will undoubtedly mark the beginning of a period in which a greatly increased number of employers will bend their efforts to ameliorating the evil of unemployment. Sound business trends and an intelligent desire for less wasteful and more profitable business management demand the regularization of employment, which fortunately presupposes regularization of marketing and production control.

It is generally acknowledged that no clear-cut "way out" is apparent for all industry or for any one industry, but it does appear that hundreds of companies representing nearly all industries have individually risen to the point of utilizing methods which have stabilized to some extent conditions surrounding their own management and their own employees.

Stabilization of Employment. In general, the remedies for our unstable employment situation are as diverse and their correlated results as little known as the conditions which have produced this instability; therefore the development of regularization methods has been experimental and largely individualistic. One of the chief points of attack, of course, has been the control of production and distribution policies in such a way as to even off violent fluctuation in volume of output and total sales. Among the elementary principles recognized as the basis for such programs is the adoption of a reasonably long-term budget based upon an intelligent sales forecast. This has ordinarily been followed in due order by corresponding schedules of weekly or monthly production in an endeavor to equalize the volume.

In many instances where products have markets too variable or seasonal for consistent sales estimates, manufacturers have attempted to lessen fluctuation in employment by manufacturing for stock.

Many companies have found it possible to diversify their operations by producing lines of products complementary to each other, thus having different periods of peaks and valleys. In other instances, seasonal markets have been extended by working up new uses for seasonal products.

Inasmuch as all these management methods for regularizing production have depended so much upon the attitude of the consumer, their limitations have been very definite; therefore inability to provide a sufficient volume of work has made it necessary to give much thought to regularization of employment. The four principal ways of alleviating this condition have been: (1) the adoption of flexible working periods; (2) inter-department and intra-company transfers; (3) unemployment reserve funds; (4) special financial systems.

Many companies have adopted the natural and reasonable practice of fitting the working periods to correspond with fluctuation in volume of orders.

There is a considerable incentive to broaden the training of employees so that they may be capable of handling several kinds of jobs.

To date our experience with unemployment compensation plans has been limited to developments by individual industrial companies, groups of companies, and trade unions. There has been considerable variation in the details of such plans. Some are contributed to only by the company, some also by the employees.

There has been an increasing use of dismissal compensation in industry, usually in cases where conditions have demanded the permanent separation of employees. The compensation has ranged from two weeks' pay upward, in some cases the amounts being gaged by length of service. In many instances employee loan funds have been set up, particularly for those who are temporarily laid off or who are on a part-time basis. In this connection many companies are establishing thrift plans to encourage employees to build up their own reserves against unemployment.

Although various legislative measures of stabilization have been under consideration, so far it has seemed wise to refrain from

enacting compulsory legislation relative to wages, hours of work, unemployment benefits, and so on.

The administrative work of Federal committees is well known. Their purpose has been to systematically spread in industry the measures which have been taken by our leading organizations.

Administration and Organization

In a large measure the American people must look to the administrators of business for a lasting solution of their present economic dilemma. This obviously places upon our financial, industrial, and commercial executives a heavy burden of responsibility. Real leadership in our social and economic activities is therefore in greater demand at the present moment than at any time, at least in the past decade. Leadership of a radically newer and more powerful order is making its appearance through a broader appreciation of the human element and its influence upon the economic stability and advancement of our country.

With the ever-increasing size of industrial enterprises, there has been shown in recent years a marked development of the line-and-staff type of organization, in preference to the pure line type or the functional type, together with a decided tendency toward decentralization and the integration of parallel or complementary staff functions by means of facilitating lines of contact and coordinating committees. More and more organizations are being built about men of exceptional ability, and less attention is being paid to conventional types of structure as the prime requisites are flexibility and the facilitation of leadership. The most significant feature in the modern structure of organization is the introduction of committees and supplementary lines of contact, arranged on a purely functionalized basis, to permit uniformity in practice and procedure and the dissemination of information from each staff function attached to a major line activity to corresponding staff functions associated with other line activities further down in the organization.

Personnel[2]

Modern labor management as a whole has by no means been abandoned. Most companies have maintained their industrial-relations programs, and some have even extended and liberalized their labor policies. Unemployment of personnel directors and their associates has probably not been greater than that of other supervisory and staff employees.

This situation, which is strikingly different from that which characterized the depression of 1921, is to be accounted for largely by the growing usefulness of modern labor management and by the increased recognition of this usefulness by the leaders of industrial enterprises.

This gain in usefulness has been due in part to the gradual acceptance of the theory that personnel management is properly a staff or advisory function in the industrial organization, and in part to the rising professional status of industrial-relations directors.

Not only are personnel managers better qualified for their jobs, but they are receiving more and more aid from science and research. Another source of aid is the increasing interest of managing executives in labor policies.

In the critical period since the collapse of the "new economic era" of 1929, labor policies have been submitted to grueling tests. With the recovery from the business depression, managers will have opportunity to appraise the results of recent experiences, discard or modify plans which have proved defective, and retain and strengthen those which have been found genuinely useful. In this appraisal, methods of wage payment will be subjected to keen scrutiny. There will be a constant demand for increased labor efficiency and reduced cost, to be secured without diminishing the consumer purchasing power upon which American industry now depends for its prosperity.

[2] From section of report prepared by E. S. Cowdrick.

Financial arrangements of the extra-stipendiary type—savings plans, stock distribution, insurance, and the like—have undergone severe testing in the depression period.

Enlightened methods for the adjustment of joint relationships between employees and management have gained in importance and recognition. Employee representation and union-management cooperation, far from being found dispensable in a period of business recession, have proved themselves even more valuable than in normal times, in that they have provided methods by which workers and officials have been able to exchange information on the changing industrial situation and compare opinions as to the methods which should be taken to meet conditions.

In the field of industrial education, emphasis has naturally shifted away from the training of new employees and in the direction of improving the efficiency and capacity of men already on the rolls. Foreman training, in particular, has made some gains and has seemingly absorbed more attention of industrial managers than during recent years of normal business.

Wages

Second only in current importance to the unemployment issue is that of wages. A veritable storm has raged between the orthodox economists, including many of our bankers, and the progressive manufacturers, including most of the engineers. The former group believes that the sooner wage rates are reduced to the same extent that commodity prices have been reduced, the sooner will be the recovery of industry. The latter group, while conceding that a proportionate reduction in money wages need not affect adversely the economic status of the worker, maintains that "the real strength of American business lies not in the maintenance of an even balance between wages and cost of living, a continuing equilibrium from year to year, but in a steady advance toward the higher standards." This group believes that it is more important to stimulate the buying power of the masses than to make further reductions in labor cost; in fact, it believes that there are many wastes which may yet be eliminated, particularly in overhead and distribution, so that total cost per unit can usually be reduced without reduction in wages.

Incentives have continued to spread into lines of work formerly considered too difficult of job standardization. For instance, they have been applied to the maintenance of track on a southern railroad, the job standard being expressed in feet per group-day. It is claimed that there was about a 70 per cent increase in efficiency.

Job Standardization

There is definitely a revival of interest in the micromotion method of job standardization. This has arisen from the General Electric Company's practice of using the full micromotion method to train their analysts, and of allowing the work of these analysts to be done without the full use of that method. This company has demonstrated forcibly that when analysts are trained by the full micromotion method they are so familiar with the principles of correct motion that they are able to make drastic improvements without taking elaborate measurements of existing work methods. This procedure, which might be called a compromise method, has spread to the Cadillac Company and a few others, so that it is receiving much attention in the press. The importance of this is that the correct principles of motions have never been well known in the practical field.

Research

More than ever before, research, in all its phases, has proved

the single factor responsible for the continuance of industrial progress and business success, and yet in these times of business recession executives are prone to discard all such activities when the volume of business seemingly does not warrant any added expense. Research in its entirety is the life blood of any enterprise. A recent survey of industrial research shows, however, that technical and product research without market research, or in fact any one phase unsupported by the other phases, will fail to produce the desired results. The report explains that a well-rounded program of research does not comprehend a large research organization; it simply means that the research function in an enterprise is being adequately fulfilled in all its phases according to the needs of the business, and that there are at least a few men in the enterprise who are constantly devising new ways and means for promoting the success of the business by applying without restriction the engineering or scientific mind to the solution of the more acute problems confronting the corporation.

With regard to management research in general over the past year, an exhaustive study is being sponsored jointly by the Management and Materials Handling Divisions of the Society pertaining to the selection and replacement of manufacturing equipment. Several engineering colleges have recently established laboratories for micromotion research. Most significant of all are a group of research projects relating to a study of human behavior in industry. One college is investigating the effect of labor-saving devices upon the human element in industry, and another the attitude of workers and supervisors, besides measuring human effort and fatigue. Other similar studies relate to vocational guidance, vocational interests, accidents, and many subjects falling within the scope of industrial psychology, the more important of which should command the attention of every industrial executive.

Education in Industrial Engineering

In the very exhaustive and valuable report of the Wickenden Committee, industrial engineering was never separated from the older engineering courses, so that it was impossible to know from these studies just what management work was being offered by the different colleges. At the present time a special study of management courses, both as given in engineering schools and in business colleges, is being made, and while the study will not be completed until next year, certain facts can now be noted.

First, the aims of these two sets of educators are much more similar than had been supposed. On the discouraging side it is evident that the various engineering curricula for management are far apart, and at best are attempting little more than elementary or general courses, which all too frequently fail to bring out the essential principles involved. On the encouraging side there is developing a better literature on management, which should in time assist teachers in getting management courses on a footing more comparable with those of the older engineering fields.

Materials Handling[1]

PROGRESS in materials handling for 1931 will be noted to be apparently more pronounced in types of equipment built as complete units by the manufacturers, such as trucks, cranes, and hoists; while in the realm of types of equipment built into and fixed in various premises, such as conveyors of all types, monorails, tramrails, etc., progress is more pronounced in new methods of arrangement, combinations, wider fields of application, and more diligent searches into cost-reduction possibilities. Portable unit movement devices such as trucks, hoists, and cranes probably lend themselves more readily to continued improvement and development mechanically by alterations, additions, and dimensional changes, and thus practically keep pace with the automotive field. Such progress is more readily apparent and ordinarily more spectacular when presented in photographic exposition, and it is a far simpler matter to present in this way a general résumé of progress in the materials-handling field.

Electric Trucks[2]

This year has produced two marked developments in the electric industrial-truck field, one with a view toward overcoming physical handicaps occasioned by low overhead clearance, and the other toward the use of power equipment for light loads and in smaller plants. A third trend which applies to both the first and second is the wider adoption of the pallet or low-clearance skid handled by the fork type of truck with the triple purpose of cutting down waste space beneath the skid—reducing the investment and providing sufficient bearing area for the tiering of goods in multiple units.

Capacities of lift trucks remain the same, the largest machines carrying a rated load of 35,000 lb. Lifting heights for tiering trucks have increased steadily, and some machines could almost be termed portable power elevators. A tiering truck has been developed that can transport material to the proper location and then raise it to any height up to 25 ft.

One of the most common difficulties met in the storage of materials is in utilizing full headroom in the storage area and at the same time being able to have the tiering truck pass through low doorways or in and out of box cars. This has been overcome through the development of the telescoping type of truck.

Another major development during the past year has been in connection with the progress made in small trucks designed to operate in narrow aisles and congested areas.

A development exemplified in elevator trucks of the fork type is shown in Fig. 1, which illustrates the method of tiering material that is bulky but light in weight with a minimum of waste space between tiers.

Heavier fork trucks have made their appearance during the year, a new design being shown in Fig. 2. These machines are not only used for tin plate and bundled steel, but are found to be excellent for general freight handling.

Along the New York waterfront, several handling records have been established with electric trucks during the past year. As examples, in the movement of rolls of newsprint from ship's side to motor truck where the rolls were tiered two high in the truck, the average during July was 70 rolls per man per hour; while in the unloading of sugar from ships by means of platform slings dropped on to skid platforms, an average of 1540 bags per hatch per hour was attained with one truck per hatch, and

[1] The executive committee of the A.S.M.E. Materials Handling Division, whose annual progress report is here abstracted, consists of Frank D. Campbell, *Chairman*, Matthew W. Potts, *Secretary*, and C. D. Bray, Edwin D. Smith, Frank L. Eidmann, Jervis B. Webb.

[2] From section of report prepared by C. B. Crockett.

even then each truck was idle about 25 per cent of the time, due to the slower speed of the ship's tackle.

In connection with the platform sling, a new type of skid has come into use on the Pacific Coast. The method is to attach the sling hooks to the inverted legs of the skid, later using the skids in the regular manner.

A summary of the progress in this field of materials handling (see Table 1) would be in terms of an enlargement of the field of usefulness by means of small, compact trucks for congested areas, higher speeds for lift and travel, greater lifting heights, and special (often interchangeable) attachments.

Loaders, Conveyors, and Apron Feeders[3]

The crawler loader grizzly shown in Fig. 3 has a helical-ribbon type of feeder with a cast-steel spiral which digs, lifts, and conveys material to the buckets. The power plant consists of a gasoline engine or an electric motor.

Fig. 1 Telescopic Fork Truck

Portable belt conveyors are being employed for handling concrete horizontally for foundation or other ground-level work. It is possible also to employ such conveyor units across depressions or soft fill which trucks could not safely traverse.

A heavy-duty apron-conveyor feeder for handling ores or other materials requiring unusual features in conveyor design has been developed in which the chains, pans, rollers, and sprockets are made of cast manganese steel. The pans are of the overlapping, flat-top type, cast in sections of manganese steel. They are carried on top of two or three strands of manganese-steel chain. The two strands, or the two outer strands when three strands are used, are located approximately one-quarter of the width of the pans from their ends.

The construction is such that the chains cannot articulate, bind, or sag below the horizontal chain centers of the material-carrying run, but are free to flex in the opposite direction and bend around the sprockets. The top or carrying run is the non-sagging portion of the feeder, and the chains are free to sag below the horizontal chain centers on the return or empty run.

Cupola Charger and Pipe-Handling Unit[4]

A cupola charger designed in such a way that no part of the hoist or bucket is in the cupola longer than the time required to dump the load, is shown in Fig. 4. One drum is used on the new charging device, and the cable from the drum is attached to the cone-shaped bottom of the bucket. The bucket is held by that cable as the hoist travels to the cupola. As the charging machine begins to enter the door, a lever which controls two hooks, shown in the figure, comes in contact with a baffle plate on the under side of the runway beam. This lever throws the

TABLE 1 SUMMARY OF ELECTRIC-TRUCK DEVELOPMENTS DURING 1931

Type of truck	Major developments
Low-lift trucks:	1. Smaller, more compact 2. Shorter turning radii 3. Equipped with cranes
High-lift trucks:	1. Telescoping uprights 2. Greater lifting heights (25 ft.) 3. Smaller, more compact machines 4. Shorter turning radii 5. Hydraulic lift
Fork trucks:	1. Telescoping uprights 2. Better maneuverability 3. Special adjustments on forks
Crane trucks:	1. Greater capacities (42,000 ft-lb.) 2. Longer booms (30 ft.) 3. Faster hoists (150 ft. per min.) 4. Special attachments
Tractors:	1. More compact 2. Shorter turning radii 3. Automatic couplers 4. Contactor controllers

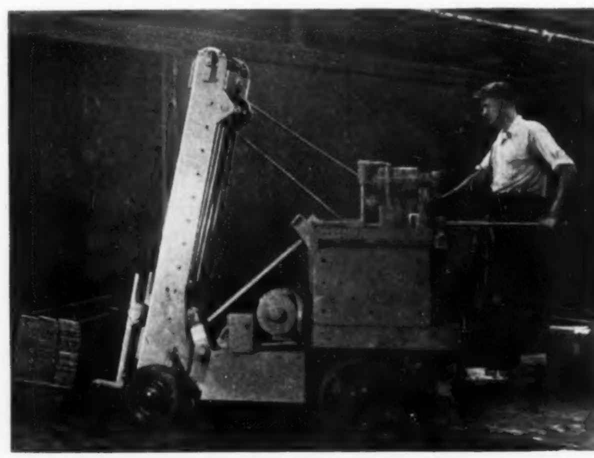

Fig. 2 Tilting Fork Truck With Hydraulic Check on Tilting Movement

Fig. 3 "Grizzly" Crawler Loader With Vibrating Screen

[3] From section of report prepared by Martin Kidder.
[4] From section of report prepared by J. O. Ferch.

hooks into position under the trunnions on the bucket. When the bucket is lowered, the hooks engage the trunnions and the cable lowers the drop bottom, which discharges the load into the cupola.

A pipe-handling unit has been brought out which has an adjustable counterweight and an improved type of trussed boom. The counterweight can be lengthened and shortened to balance the loads to be lifted or carried. The trussed type of boom is so designed that heavy close-radius loads can be suspended from the center of the boom. Long-radius work is served in the normal manner from the boom tip.

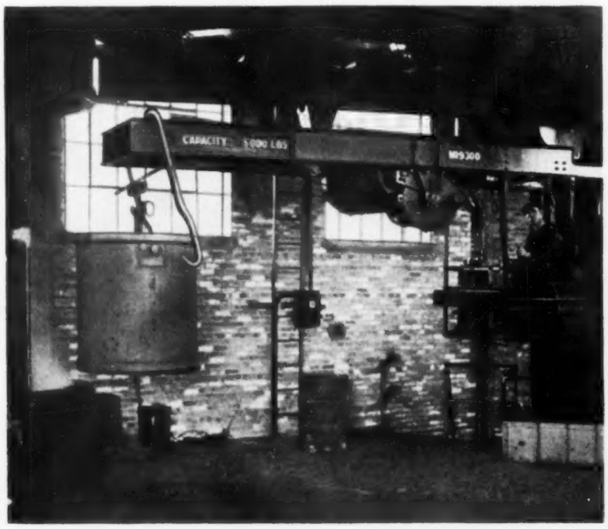

FIG. 4 CUPOLA CHARGER WITH MINIMUM HEAT-EXPOSURE

FIG. 5 ADAPTATION OF TWO HAND-LIFT TRUCKS FOR LONG LOADS

The unit has two side drums and a front drum, making it possible to work off either side or over the front of the machine by changing the boom from one position to another. Having drums on either side, the machine can also be used for backfilling. When joining a welded-pipe section of several hundred feet to the main line, the butting end of the pipe can be lowered accurately into alignment with the end of the main line, using the side boom. At the same time the front drum is used for snaking the section along the skids until the end is in the proper position for welding to the main line.

HAND-LIFT TRUCKS[5]

Fig. 5 shows the adaptation of two hand-lift trucks for the handling of 10-ft. long, 5000-lb. loads of veneer. The forward truck, being equipped with a turntable, permits easy maneuvering, and the rear truck is steered by hand to follow.

A 20,000-lb. hand-lift truck has been developed for use in handling assembled marine engines from the assembly department to the shipping room. The use of a self-locking ball-bearing-mounted worm operating in oil for the lifting mechanism assures absolute dependability and ease of operation.

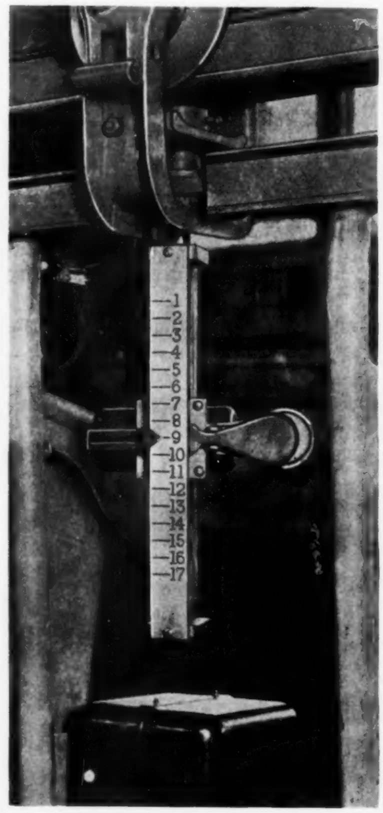

FIG. 6 TRAMRAIL SYSTEM CONTROLLED BY PHOTO-TUBE RELAY
(Selector bar set for station discharge.)

A portable hammerhead crane is now being built in capacities up to 2000 lb. for general lifting about the plant.

A self-contained sectional dumb-waiter has been devised which requires no attachment to the building where installed. The hoisting mechanism is contained in the upper unit, and the doorways are located in the first and third units. Any number of intermediate units can be inserted to accommodate any height of lift.

ELECTRIC HOISTS[6]

A large cement mill operated two conveyors to carry bags of cement from storage to the loading platform. When the conveyors were not in use they rendered a large portion of the platform space useless. Hinging them at one end and placing an electric hoist over the free end was the solution of the problem. Other uses of electric hoist noted are: quick removal of movietone speakers, etc., etc.

CHAIN HOISTS[7]

A new hand-power chain hoist, in capacities up to 2 tons, inclusive, made of aluminum alloy, has been developed. A one-half-ton-capacity hoist, complete with chains, weighs 38 lb.

One of the developments incorporated in this hoist is a safety overload governor built into the handwheel. It is set at a 50 per cent overload and sealed at the factory. If an attempt is made to lift a load in excess of 50 per cent overload, the hand-

[5] From section of report prepared by F. J. Shepard, Jr.
[6] From section of report prepared by H. S. Thoenebe.
[7] From section of report prepared by E. J. Byrne.

wheel will turn free and the load remain stationary. When the excessive overload is reduced the hoist will function normally.

Tramrail and Cranes[8]

One of the interesting developments of the present year has been the photo-tube relay control of overhead material-handling equipment.

A photo-tube-relay-controlled system has been adapted for handling mail sacks at railway terminals. This proposed system consists of several trains of forty or more carriers, each carrier holding one mail sack. The operator at the loading platform puts one bag of mail on each carrier and as the carriers pass the selector station the operator here by manipulating the selector bar, shown in Fig. 6, sets the tube in such a position as to be actuated by the light source, located at the station for which the tube is set. As the carriers pass this station the beam of light passes through the slot in the selector bar, operating the photo-electric tube, which in turn checks the relay, automatically dropping the bag of mail into a chute, which in turn permits it to slide directly into the mail car. The train continues to travel to the loading platform. At a conveniently located position on the tramrail system the trays of the carriers come in contact with two ingeniously bent and arranged pieces of steel tubing, which automatically return the trays to a horizontal position, ready for another bag of mail as they arrive at the loading platform.

There is an increasing trend in overhead-traveling-crane construction in the use of ball and roller bearings, and of welding of standard structural-steel shapes. With the application of roller bearings, the crane has increased its worth as a production tool. Crane speeds have been increased by faster acceleration as well as running speed to such an extent that in many factories two

Fig. 7 Floor-Level Roller-Conveyor System for Assembling Gasoline Pumps

cranes are serving where three were formerly required. The cranes of yesterday operated with a bridge traveling speed of 300 to 400 ft. per min. Today cranes are operating at 600 to 700 ft. per min. Likewise the hoisting and trolley-travel motions have been proportionately increased in speed.

The application of welding to the manufacture of crane units has advanced with the art of electric welding. For many years the trolley or hoisting-machinery carriage and the end trucks were made of castings. Bridge girders have been manufactured with rivets for years as the standard construction. The application of the electric arc has replaced both the casting and the rivet by welding standard structural-steel shapes into one solid unit.

Fig. 8 Automatically Alternating Two-Way Roller-Conveyor Switch

The following table shows the trend toward welded units and expresses the percentage that welded crane units form of the total number of crane units built:

Year.........	1928	1929	1930	1931
Per cent......	28	43	58	70

Of the units considered, bridge girders have shown the greatest increase in recent years in favor of welding. For a like period of time, 1930 and 1931, show a 30 per cent increase in the number of welded girders over 1929.

Roller Conveyors[9]

As an example of progress in the use of roller conveyors, an installation shown in Fig. 7 illustrates a method of transit in the assembly of gasoline pumps. The geographical arrangement prescribes a fixed line of travel and determines the exact method of work in proper sequence of process.

The conveyors, being flush with floor level, do not impede passage in any direction, and in this feature constitute a mobile floor surface.

[8] From section of report prepared by John R. Booher.

[9] From section of report prepared by W. J. Ramsay.

At the head of the conveyor line is an air lift sunk in a pit and having a roller-conveyor section as its top. Its high point is at about waist-high level, and an operator places on the rollers a large casting, which is the base of a pump, to which the vertical side pieces are assembled with the operator in standing position. By means of a foot pedal the hoist is lowered. At its lowest point the hoist aligns its own rollers with those of the assembly line, when the structure of the pump is moved off and begins its journey around the system.

At required points along the assembly line of roller conveyor there are roller-conveyor turntables upon which a number of assembly operations are carried out. A pump is moved on to a turntable, which is lined up with the fixed conveyor. Then by means of a foot pedal the operator at the assembly station releases the lock and turns the table into the position that makes it easiest for him to work upon the pump. The pump may then move on to the next operation.

Automatic Two-Way Switch

Steel plants have had a requirement for a reliable, trouble-free switching mechanism capable of receiving hot sheet packs from both sides of a continuous furnace alternately and automatically delivering them to the mill in alignment. The automatic two-way switch shown in Fig. 8 has a heavy structural-steel frame, rigidly welded into a complete unit, and on which are mounted the wheels which bear the load. The pivoted switch sections are arranged to raise or lower automatically and alternately so as to receive sheet packs from either side of the furnace. The switch can be remote-controlled in several ways—by a standard motor, coupling connected, worm-gear reducer and chain drive, or through electric or pneumatic operators. It can also be controlled by hand, since one attendant can easily operate the switching mechanism to meet the rate of discharge of sheet packs from the furnace.

New Shipping Container Offering Bin-to-Bin Delivery

A new car body for railroad use has been developed which, for the first time, provides actual bin-to-bin delivery of merchandise without any equipment other than a motor truck and the car body itself. Losses in box car transportation have been cut from $4^1/_2$ per cent to less than 0.1 per cent with shipping containers, but they required expensive overhead equipment and special gondola or flat cars. The new car body is equipped with air-operated wheel jacks, upon which it is raised or lowered. It rests on the flat bottom of the car, and rollers allow it to absorb impacts or sudden stops or starts, while "hold-down" clamps keep it from rolling too far.

The motor truck used with the car bodies is equipped with a platform which can be elevated either horizontally or tilted as a sharp angle. Power from the motor of the truck raises and lowers this platform, and also moves the container on to the flat car.

Oil and Gas Power[1]

DURING the past year progress in oil- and gas-power engineering has brought out nothing revolutionary. Rather has this progress been along the lines of refinement and improvement of already well-established types of engines, and further development of new and radical types of engines and forms of application that have been commented on in previous reports. A feature of oil-engine development is the progress that has been made in adapting the oil engine to services that have heretofore depended exclusively on the gasoline engine for power, particularly in the automotive and aircraft fields. Marked progress has been made along the lines of increasing the speed and reducing the specific weight of oil engines. The Progress Report for the year 1927 contained the statement that "1927 has marked the beginning of what may prove to be a long struggle for higher speeds.....The present trend is unmistakably toward higher speed in order to obtain more power per pound of engine weight." The prophetic quality of this statement is attested to by the fact that in the past year, in practically every field of application of the oil engine, there has been a marked stepping up of rotative speed, and there have been new applications that are made possible only by this high speed. Among the tendencies noted in previous years which have continued during the past year is the application of mechanical injection of fuel to large engines. So marked is this tendency that mechanical injection promises to become standard for oil engines, with air injection used only where special conditions render its use advantageous. Refinements in design and construction and increasing knowledge gained from fuel-spray and combustion research continue to improve the thermal and mechanical efficiency obtainable with the oil engine. Fuel consumption as low as 0.35 lb. per b.hp. is now quite practicable.

[1] The executive committee of the A.S.M.E. Oil and Gas Power Division, whose annual progress report is here abstracted, consists of Louis R. Ford, *Chairman*, Edgar J. Kates, *Secretary*, and Ralph Miller, Harte Cooke, L. M. Goldsmith ,Laurence B. Jackson. The original report was prepared by Louis R. Ford.

Stationary Oil Engines

The oil engine continues to be a standard type of prime mover for all types of power plant in the small-power field, but a new high was reached this year when the city of Copenhagen awarded a contract to Burmeister & Wain for a double-acting engine of 22,500 b.hp., for installation in the municipal electric plant.

A feature of power-plant practice that is receiving attention is the possibility of using oil engines in conjunction with steam engines to balance the heat and power output. An example is found in the R. H. Macy & Co., New York City.

Another important forward step in power-plant practice during the past year has been the placing in service of a completely automatic, multiple-unit Diesel-electric power plant, supplying the entire requirements of a New York City hotel. In this plant the units start and stop automatically in accordance with the load; the engine supply services are automatically safeguarded; in case of trouble with any unit it is automatically shut down and another put into service; steady voltage is maintained under all conditions of fluctuating load. The complete elimination of all manual control from a plant operating under conditions of wide and rapid variations of load bears eloquent testimony to the efficiency and reliability of the modern Diesel engine.

Further progress has been made toward the determination of the cost of power in stationary Diesel plants. The subcommittee on Oil-Engine Power Costs has collected a large amount of data which are carefully analyzed in its annual report.

It is of interest to note that in Switzerland, where water-power plants abound, a great many Diesel engines of large power are being installed by electric power companies. An 8-cylinder, double-acting engine of 11,000 hp. recently completed by Sulzer Bros. for a power concern will operate in parallel with a hydraulic plant during the annual period of reduced water flow. Three more similar engines for the same sort of service are under construction by the same firm.

It should be noted that development of the coal-dust Diesel engine is continuing. Although there has been no incentive for development of this type of engine in the United States, it should be considered as one of the possibilities of the future. A single-cylinder unit of 80 hp. was built in Germany in 1924, and since then has operated 9000 hours on coal dust, wood shavings, coke breeze, rice hulls, and flour-mill refuse. Improvement has been along the lines of prevention of tar formation, freedom from slag, and prevention of sticking of piston rings and exhaust valves. Recently the firm Kosmos has converted several oil engines, including a vertical two-cylinder unit of 100 hp., to coal-dust operation.

Progress in the application of mechanical injection of fuel is shown in the 3750-b.hp. engine recently completed by Busch-Sulzer for the Federal Light and Traction Company, Tucson, Ariz. The cylinders are 30 in. bore by 42 in. stroke, the largest cylinders built to date for mechanical injection. The trend toward lighter specific weight is emphasized by the 3000-b.hp. trunk-piston engine produced by this same firm, in which the weight has been brought down to 80 lb. per b.hp.

What will be, when completed, the largest Diesel power plant in existence is projected by the city of Vernon, Calif. It will include five M.A.N.-type, 2-cycle, double-acting engines, of 7000 b.hp. each, which are now under construction by Hooven, Owens & Rentschler.

Marine Oil Engines

Progress in marine oil-power engineering in the United States has been confined exclusively to engines for small craft, principally yachts and towboats, but in foreign countries the Diesel engine as motive power for large seagoing ships continues to exceed the steam engine and steam turbine in number and power of installations. The extreme depression in the shipping business has acted to reduce the number of ships on order, but the installations that have been completed in the past year offer some splendid examples of the progress being made in marine Diesel engineering.

The most noticeable trend is toward the use of higher speeds, in marked contrast with the trend of a few years ago, which was almost wholly toward slow speed. Among other noticeable signs of progress are: the increasing use of mechanical injection (about one-half of the motorships now under construction use this system of injection), increasing use of waste-heat boilers, the return of the trunk-piston type to favor, and the use of supercharging, multiplicity of cylinders, and high speed to obtain high unit powers.

The outstanding motorship of the year is the *Victoria*, a most luxurious passenger liner of 13,500 tons and 17,000 b.hp., built for Lloyd Triestino, to operate on the Triest-Alexandria run. Built for a sustained cruising speed of 20.5 knots, this vessel attained a speed of 23.25 knots on trial. The engines are four in number, of Sulzer design, and each have eight cylinders and operate at 126 to 130 r.p.m.

Another outstanding vessel, in the machinery of which may be noted the design trends listed, is the *Reina del Pacifico*, a 17,300-ton passenger liner. The high power required for this vessel, 22,000 b.hp., is developed by four B. & W. trunk-piston engines with 12 cylinders each, operating at 145 r.p.m., supercharged.

The trend toward higher speeds that exists in all Diesel-engine design may be noted in the auxiliary engines installed in motorships during the past year. Formerly 250 r.p.m. was about the maximum speed allowed for these engines, but it is now common to use 400 to 450 r.p.m., with every indication that still higher speeds will be used in the future. The tremendous improvement in thermal efficiency of the turbine steamships that was forced by motorship competition has been matched by a similar improvement in the efficiency of the latter. At the present time the most efficient steamship shows an economy of 0.65 lb. of fuel per b.hp. for all purposes, while the corresponding economy of the most efficient motorship is 0.38 lb. per b.hp.

Automotive Oil Engines

Application of the oil engine to automotive work has developed to the point where oil-engine-driven trucks and tractors may be considered as commercially established. The previously noted trend toward high speed and reduced weight has been stimulated by the fact that these two things are absolutely essential in automotive work, and the extent to which the oil engine will compete with the gasoline engine in this field will be measured by the progress that can be made in increasing the speed and reducing the weight. Development of the oil-engine truck has been more active in Germany and England than elsewhere. Reported tests of heavy motor trucks in England show great reliability in service and an increase of 50 to 75 per cent in miles per gallon of fuel, as compared with similar gasoline trucks. The fine performances of the Hill Diesel truck in this country are doing a great deal to attract attention to the possibilities of this type of vehicle. Interest of the automobile manufacturers in the United States in the oil engine has been aroused and a great deal of research and development work is under way in various automobile plants, but this work has not yet reached the stage where the details can be made public.

A detail of development of the automotive oil engine that is receiving considerable study is the matter of easy starting. The very high compression associated with best economy imposes starting difficulties not found in the gasoline engine. Two methods of reducing compression for starting may be found in existing engines: the use of compression release valves, and variable clearance volume. In the second the variation in clearance volume is obtained either by a movable cylinder head or a double combustion chamber. A variation is found in the recently announced Hesselman oil engine for motor vehicles, in which a compression ratio of only 5.5 to 1 is used. In general, it may be said that automotive-engine design is at present in a state of flux, and that no definite standards of practice have yet been evolved.

Aircraft Oil Engines

In trying to meet aircraft-engine weight requirements we find the most compelling motive for high speed, and the year's progress has been principally in the direction of intensive study of means to increase the speed and obtain the resultant decrease in specific weight. In the United States the leading development is the Packard aircraft engine, which has emerged into the commercial stage. A plane equipped with this motor now holds the record for non-refueling flight. The Navy Department has continued its efforts to produce an aircraft oil engine, but has as evolved no final design. In Europe the Maybach, Beardmore, Sunbeam, Junkers, Clerget, Garuffa, and Jalbert engines are being actively developed.

The opposed-piston principle is utilized in the Junkers aircraft engine, which develop 650 hp. at 1500 r.p.m. The cylinders are of the aluminum alloy silium, and a specific weight, with oil and water, of 2.85 lb. per b.hp. is claimed. An interesting feature of this engine is that four open fuel nozzles are used, with an injection period of $^1/_{1000}$ sec. The opposed pistons connect to separate crankshafts, which in turn connect to a common shaft by gearing.

An interesting variation in injection procedure is found in the Jalbert engine, under construction for the French Air Service. A separate fuel-compression cylinder, mounted on each working cylinder, is used to compress a rich fuel mixture, which is then

injected into the working cylinder. The fuel mixture is supplied by a carburetor instead of a fuel pump.

Considering the aircraft oil engine in general terms, it seems that the most important object to be attained is reduction in weight. Even with improved materials now available this weight cannot be brought down to that of the gasoline engine unless speeds equal to those of the gasoline engine are used. The fuel-spray research now in progress, referred to in another section, seems then to be of vital importance to the further development of the aircraft oil engine, since injection and combustion control hold the key to higher speed.

LOCOMOTIVE OIL ENGINES

Development of the oil-engine-driven locomotive has proceeded during the year. About 100 locomotives are now in use in the United States and Canada, but the development work seems to be of a more varied nature in Europe. The Diesel-electric principle seems to be generally accepted as best in this country, but in Germany a great deal of work has been done on transmission of power by gearing and hydraulic clutches.

The Baldwin Locomotive Works has for some time been developing a 1000-hp. Diesel-electric switching locomotive. After disappointing results with an untried Diesel engine of poor design, an engine of more conventional design was installed and the locomotive has been given severe trials in the yards of various railroads with excellent results. At the present time Sulzer Bros. in Switzerland have under construction a total power of 15,000 hp. of engines for locomotive drive. Several Diesel-electric locomotives of 1700 hp. each, designed for one-man operation, are being built in Switzerland.

NAVAL OIL ENGINES

Naval oil-engine progress in the United States has been confined to efforts to develop a satisfactory submarine engine. These efforts have not yet resulted in a suitable American design, and intensive study of European designs is now in progress.

Progress in naval oil engines that is likely to have a strong influence on future naval policy is demonstrated in the remarkable light cruiser *Deutschland*, launched in Germany recently. This vessel displaces 12,000 tons and has a speed of 26 knots. Eight M.A.N. engines of 6250 to 6750 b.hp. each give a total of 50,000 to 54,000 hp. The drive is through Vulcan gearing, and the total weight of machinery, exclusive of gears, has been reported to be 20 lb. per b.hp.

MATERIALS AND PROGRESS

Improvement in materials of construction continue to receive the attention of metallurgists, and such improvements have made possible much of the progress that has been made in oil-engine design. Aluminum-alloy pistons are an established feature of high-speed engines, and the use of alloys for other parts is steadily increasing. The use of welded steel for cylinder heads was a feature of progress commented on in a previous report. This method of construction has proved so successful that the A.E.G. is now using the same method for pistons. This year finds the welded-steel principle extended further in an engine now under construction by Messrs. Davey, Paxman & Co., in England, in which the entire frame is being fabricated of steel plate. This engine will be of 375 b.hp. at 750 r.p.m. and will weigh 27 lb. per b.hp.

RESEARCH

Among the most important research projects carried on during the past year has been that of the Fuel-Oil Research Committee. During the year the importance of this work has been recognized by other societies, and arrangements have been made by which the A.S.M.E. is now allied with 11 other societies and associations in this particular work. The Committee now has three distinct projects under way, through the medium of subcommittees. These are: 1, study of combustion and spray research from theoretical and laboratory angle; 2, study of physical and chemical properties of Diesel fuels in laboratories of oil companies; 3, carrying out of field tests in shops of various engine manufacturers. It is probable that the assembly and analysis of the great amount of injection, spray, and combustion research results obtained by numerous independent investigators will have an even more important bearing on the problems of high-speed-engine design than on the preparation of oil-fuel specifications, the purpose for which it was started.

PENNSYLVANIA STATE COLLEGE

Pennsylvania State College has continued its studies of fuel sprays and associated apparatus, also a number of engine-building concerns have continued to devote considerable time and money to similar research in their own plants. The importance of this work cannot be overemphasized, as the progress to be expected in further high-speed-engine development will be dependent largely on the knowledge obtained from it.

NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

The National Advisory Committee for Aeronautics has continued its oil-engine spray and combustion research. Some of the more important investigations in progress or completed are: determination of effect of injection pressure and air density on spray penetration, spray-cone angle, and coefficient of discharge for a range of orifice sizes having length diameter ratios 0.5 to 10; determination of the effect of high air velocities on distribution and penetration of fuel sprays at atmospheric pressure and room temperature; study of individual sprays by means of high-speed motion pictures and an oscilloscope to determine penetration and duration of sprays; construction of equipment to determine the instantaneous rates of fuel discharge from pump-injection systems; determination of atomization and distribution characteristics of high-speed-engine sprays in high-density air; determination of the extent to which combustion in high-speed engines can be controlled by varying rates of fuel injection; determination of the performance characteristics of the pre-combustion-chamber type of engine; and determination of combustion characteristics of fuel sprays.

GAS ENGINES

An important development in the gas-engine industry is associated with the gasoline pipe line from Texas to St. Louis, recently completed by the Phillips Pipe Line Co. This is an 8-in. line running from Borger, Texas, to St. Louis, Mo. The gas engines for driving the gasoline pumps are operated with butane gas. Liquid butane is pumped through the line with the gasoline, drawn out at the various pumping stations, and stored in tanks. Heat obtained from the engine jacket water is used to vaporize the butane preparatory to induction into the cylinders. An interesting feature of these engines is that they can be quickly converted to Diesel operation by changing the cylinder heads and replacing the magnetos with fuel pumps.

GAS TURBINES

In the gas-turbine engineering field search continues for metals that will withstand the high-temperature conditions associated with gas-turbine operation. In the Lorenzen turbine design, mitigation of this high-temperature condition is sought by the use of hollow blades through which air flow is induced. This method serves the double purpose of cooling the blades and compressing the air, permitting use of the turbine as a supercharger.

The Oil Industry[1]

Oil Refining[2]

CONSIDERING the wide publicity given to overproduction of crude oil, with consequent flooding of the market with products, particularly noticeable with motor gasoline, there are given the following general statements pertaining to the business of oil refining, so that the reader may compare it with the situation in other industries.

There are at present 435 completed refineries in the United States, capable of running each day to stills, for straight-run distillation, 3,988,000 bbl. of crude (42 gal. per bbl.). The "cracking" capacity is 1,951,000 bbl. per day.[3]

It was estimated by the Federal Oil Conservation Board, as well as by a committee of the American Petroleum Institute, that during the latter half of the present year the crude requirements to be met would be 2,390,000 bbl. per day, which is 60 per cent of the crude running capacity of all the refineries in the United States. If all the refineries could maintain the 1930 average total gasoline yield (straight-run and cracked) of 41.9 per cent of crude throughput, and if they would blend with the straight-run their cracked gasoline, so as to produce enough gasoline to bring the total up to specifications, they could supply over 1,850,000 bbl. of finished gasoline per day. This potential gasoline-manufacturing ability is almost 450,000 bbl. per day in excess of the peak of the combined domestic and foreign demand for U. S. gasoline which occurred in 1930.

However, instead of producing this amount of gasoline, the refining branch of the industry has confined the operation of its refining facilities to only about two-thirds of capacity during the peak summer period of the present year.

In consequence of this situation, the development in the oil-refining industry has not been so much in additional plant as in the improvement in quality of product by economical expenditures for modifications of equipment, and in the changes of methods of operation so as to increase the percentage of time on stream for those units in use, at the same time trying to keep down the time and expense for cleaning and repairs.

There has been some tendency among the larger refiners to confine purchases of new distillation and cracking equipment to larger units, more efficient in labor and fuel—the latter being the most important item—wherever improvements in process were available, that would result in existing plant becoming economically obsolete. Particularly has this been true in cracking operations.

In comparing crude fractionating units with cracking units, it should be noted that the former have a capacity rating in barrels charged, while the latter have a capacity rating in accordance with the yield in barrels of pressure distillate, which will usually vary from 30 to 50 per cent of the charge on a once-through basis. The ratio of recycle oil to fresh charge and yield in the cracking process would make comparison impossible on the basis used for crude fractionating stills.

One eastern manufacturer[4] has built a tube-type cracking still for a well-known process, having a capacity of 50,000,000 B.t.u. per hour, which would correspond to a yield of about 2000 bbl. of pressure distillate per day. He has also built several combination units, respectively of 200, 300, and 500 bbl. per day capacity, for the use of various small refiners who wish to produce lubricating oils or asphalts as well as the lighter products. These are capable of being run under either atmospheric pressure or vacuum.

Another eastern contractor on refinery construction reports a total of twelve units of a cracking process involving vapor-phase cracking, of which six have gone into operation this year, each unit being rated at 1000 bbl. of distillate per day. It should be noted here that pressure distillate is a crude motor gasoline which must be further treated and refined, which includes stabilization, and blended to meet acceptable specifications.

In general, the cracking processes require higher operating pressures and temperatures than fractionating processes, excepting the comparatively new process of hydrogenation which was referred to in last year's report.[5]

Such cracking processes require heavy-walled pressure chambers, of which the following may be cited as notable examples for the present year.

So-called soaking drums or reaction chambers made by a fusion-welded process, 60 in. inside diameter, walls $4^3/_8$ in. thick, in which the corrosion allowance is $^3/_8$ in. The overall length is 43 ft. $7^3/_4$ in., and the ends are fitted with ellipsoidal heads $4^5/_8$ in. thick. These chambers were designed for a safe working pressure of 750 lb. per sq. in. at a temperature of 925 deg. fahr., and subjected to a hydrostatic test pressure of 2544 lb. per sq. in. Approximate weight, 75 tons. (See Fig. 1.)

The same company also reports evaporator towers, 9 ft. in inside diameter by $1^1/_2$ in. thick, likewise of welded fabrication, made of rolled seamless steel cylinders; operating pressure, 180 lb. maximum at 900 deg. fahr.

These steel cylinders are made of seamless rolled rings, rolled from pierced ingots of American manufacture, shipped at a maximum weight per section of 25 tons.

Low-pressure bubble towers are made by the same process up to 14 ft. inside diameter. The average length of such cylinders before welding together is approximately 9 ft. 6 in. Operating temperatures may run up as high as 1000 deg. fahr., although the stream issuing from the pipe-coil heaters on some cracking stills may reach a maximum of 1100 deg. fahr.

A mid-western manufacturer reports that during the past year he has made by fusion welding vessels 10 ft. in inside diameter by 40 ft. long, with 3-in. walls, for 900 deg. fahr. operating temperature, and some of similar diameter 62 ft. long, with $3^1/_2$-in. walls, for 850 deg. fahr. operating temperature. Such vessels may have an allowance for corrosion up to 1 in. These vessels are only given as examples of their product, and in this instance happen to be for 300 lb. operating pressure, although this is not by any means the maximum encountered in some cracking processes.

With respect to hot-oil charging pumps, centrifugal pumps are still finding favor with many refiners, one California refiner reporting such a charging pump for a capacity of 30,000 bbl. per day, which means close to 1200 gal. per min. of hot oil, at a discharge pressure of 1000 lb. per sq. in.

The preference of refiners for centrifugal pumps on such service is, however, not universal, as in some plants the available space is sufficient to permit reciprocating installations

[1] The executive committee of the A.S.M.E. Petroleum Division, whose annual progress report is here abstracted, consists of W. G. Heltzel, *Chairman*, H. J. Masson, *Secretary*, and Harold Adkison, *Mid-Continent Secretary*, Walter Samans, J. W. Hays, E. H. Barlow, D. L. Trax.

[2] From section of report prepared by Walter Samans.

[3] From a statement prepared by the American Petroleum Institute for the Committee of the Whole, House of Representatives, Legislature of Texas, July 27, 1931, in printed form and entitled "The Oil Situation."

[4] Names of manufacturers cited will be furnished by the author upon request in writing.

[5] See Mechanical Engineering, February, 1931.

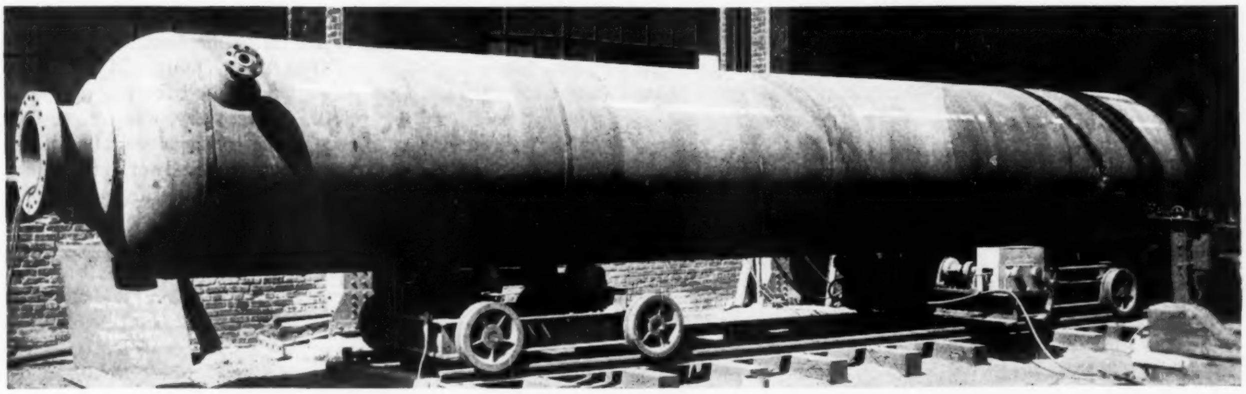

FIG. 1 REACTION CHAMBER MADE OF SEAMLESS ROLLED RINGS JOINED BY ELECTRIC FUSION WELDING. WEIGHT, 75 TONS

which may require ten times the floor space, but show a great saving in operating expenses, particularly where refinery gas is used for motive power.

One pump manufacturer reports such a gas-engine-driven unit installed in an eastern seaboard refinery, made up of two 20 × 30-in. gas engines, each developing 460 b.hp. at 150 r.p.m. These are direct connected by means of a flexible coupling to two $5^1/_2$ × 24-in. end-packed plunger pumps operating at 46 r.p.m., at which speed they have a capacity of 433 gal. per min. of oil at 700 deg. fahr., and with a discharge pressure of 1500 lb. per sq. in. The guaranteed gas consumption of these engines is 10,000 B.t.u. per b.hp. The weight of the engine is 115,000 lb., and the weight of each pump, 83,000 lb.

In the operation of cracking units, only a few years ago ten to twenty days continuous operation without shutdown for cleaning was considered average practice. Some types of units are now run 1000 hours, and one recent report of a unit in operation gives over 1500 hours as the operating time.

A western refinery[6] reports a new 10,000-bbl. tube-and-tank cracking unit just started in operation, in which the reaction chambers weigh 125 tons each, being 6 ft. in diameter and 45 ft. long, with walls 6 in. thick. (Further details can be obtained from the reference given.)

As to the anti-knock value of motor gasoline,[7] referred to in the 1930 report, the need for a standard test and equipment for the anti-knock quality of gasoline has been felt for a long time. During the past year the Detonation Subcommittee of the Coöperative Fuel Research has adopted standard equipment for this test the so-called C.F.R. engine as manufactured by the Waukesha Motor Co. They have also adopted and published a tentative method of test using this equipment. The test and equipment are being adopted quickly, not only in this country but abroad.

Another use for cracking equipment has been found, for somewhat over a year, in the raising of the anti-knock value of straight-run gasoline by putting it through the cracking process, either alone or together with the rest of the crude. This development is the result of the greater demand for anti-knock gasoline and the decrease in demand for gasoline of low octane number.

One of the improvements in the refining of lubricating oils has been the increased adoption of continuous acid-treatment methods. Centrifuges have been used for completing the removal of the acid sludge from the oil.

There have been no new developments in the dewaxing of oils, but there is still an increasing tendency to lay stress on dewaxing at low pour, and more manufacturers are dewaxing at lower temperatures than heretofore.

There is a slowly developing demand for exceptionally high-quality motor lubricating oils. The use of solvent extraction for the manufacture of such oils has been much discussed and several patents granted. The Standard Oil Company of Indiana has also announced a method of making them synthetically.

There is a rapidly expanding demand for a lubricant which will withstand much higher pressures than ordinary oils. This demand has been chiefly occasioned by the trend in the automotive industry toward hypoid gears in the differential, used for the purpose of lowering the body of the car. While the teeth in these gears have about the same bearing pressures as those in the conventional spiral bevel gear, the sliding friction occurs at a much higher speed, and the oil film is therefore subjected to a considerably greater strain. The first attempts to meet this situation by incorporating a lead soap were not altogether successful, but it has been shown that a combination of lead soap and sulphur is effective. Several other methods of improving the oil have been suggested. The load-carrying capacity of these oils acting as "border-line" lubricants has been increased from about 10,000 lb., as measured on the testing machines for straight petroleum oils, to about 25,000 lb. on the oils under demand.

During the last year, the orders placed and projects planned to bring refinery absorption and stabilization units up to date very definitely indicate that refineries having competent management all feel that such work is a competitive necessity.[8] To the best of the writer's knowledge, only two or three companies, and in these cases companies which are not fully informed on the subject of vapor recovery, have failed to recognize the need for up-to-date equipment. Debutanization of pressure distillate is being rapidly adopted, and the need for such installations will soon be as generally recognized as the need for the tail-gas plant or the high-pressure stabilizer.

In the writer's opinion the increased rigidity of gasoline specifications and the variation of specifications at different times of year, make debutanizers and stabilizers absolutely essential to provide the necessary operating flexibility to meet the varying requirements economically.[8]

Pressure Vessels. A joint committee of the A.S.M.E. and the American Petroleum Institute is being contemplated to study the problem of pressure vessels and to formulate codes which will be satisfactory to both parties, and without prejudice to their ultimate agreement in the matter.

Storage Tanks. There has been a greater tendency toward the

[6] See *Oil & Gas Journal*, Aug. 27, 1931, p. 15.
[7] Contributed by Dr. J. B. Hill.
[8] Contributed by G. M. Jackson.

adoption of floating roofs in refinery working storage and distillate receiving tanks, as well as in finished-gasoline storage. One large manufacturer in the Great Lakes territory reports about 500 floating roofs of the following dimensions built during the last two years:

Per cent	Diameter, ft.
8	10 to 30
31	31 to 50
13	51 to 60
14	61 to 80
10	81 to 100
23	101 to 120
1	over 120

A number of the larger tanks in this list are in crude and finished storage.

During the same period, twenty-three spheroids, ranging from 2500 to 20,000 bbl. capacity, have been constructed for light-gasoline and casing-head storage.

Petroleum Production[9]

Progress in drilling in the past few years, has been almost entirely confined to improvements of rotary drilling equipment and even that progress has been held back within the past year due to curtailment of drilling.

The advent of rotary drilling, for which some blame the present condition of overproduction, has brought about many changes and developments. Since such equipment as prime movers, draw works, slush pumps, rotary tables, drill pipe, rotary drill bits, drill stem, automatic catheads, etc., have become common to all those interested in the production end of the petroleum industry mention will be made only of some of the more noticeable results in design, tending to affect the efficiency and economy of deep-well drilling.

Poorly designed babbitted bearings are being replaced by roller bearings to some degree on gas engines and transmission equipment, and the use of endless rubber belts with idlers is prevalent and indicates a more efficient means of transmission of power than belting using fasteners. Sprockets and chains have also been used to some extent in transmitting power.

Extensive studies on drill pipe have resulted in limiting the diametral size because of the increased torsional load imposed when the rotation is slacked, and which often shears the pipe. Better steels, which will stand up longer under fatigue stresses, are being used in drill pipe.

Rotary bits have been faced with tungsten carbide alloys, thus prolonging their life in hard formations. More attention is being paid to the effectiveness of the type of bit to be used in drilling through various formations.

A stuffing box, through which the drill stem may be lowered while rotating, has been devised for use in drilling through high-pressure-gas sands.

In order to regulate the feed of the drill a hydraulic feed has been developed which, coupled with a weight indicator, assures an even feed of the drill, and thereby increases to a marked extent the possibility of a straight hole. Further, by using the weight indicator and hydraulic feed, undue stresses in the equipment are avoided. Weight indicators are commonly used now in almost all operations.

Constant improvements are being made in the design of all types of prime movers, outstanding among which are steam-turbine-driven slush pumps, the adaptability of the Diesel engine, and hydraulic turbines to drive the draw works. Diesel and gas engines are being used, both in mechanical connection with the drilling equipment and as generating plants, the direct-current generator providing a source of power which gives a flexible unit. The hydraulic-turbine drive for the draw works is limited to ideal locations for its application.

[9] From section of report prepared by Harold Adkison.

The extraction of the oil from the ground has been studied and treated in a different light. The need for the utmost efficiency, resulting in larger ultimate recovery, was noticed more quickly here than in drilling. As a consequence, lower lifting costs have been brought about by a careful study of the mechanics of pumping equipment and the development of improved pumping units. No longer is it considered necessary, for maximum production, to pump as rapidly as possible, as it has been proved in many cases that this is detrimental. Air- and gas-lift methods of extraction are not new, but more is being learned about them, and with the study being instituted by the Bureau of Mines and the American Petroleum Institute to determine the actual underground conditions under which gas and oil are associated, more progress in this line is assured. The engineer has long been interested in the vital subject of the solubility of gas in oil and the underground conditions under which these fluids exist, and the finding of ways of securing accurate data concerning them is an accomplishment indeed.

By the application of devices, both mechanical and electrical, whereby bottom hole pressures and temperatures may be recorded, the rate of depletion and the effect of different methods of operation can be readily ascertained, thus eliminating guesswork and the trial-and-error system of determining underground conditions, and thereby reducing the operating costs.

Nearly all wells are now flowed through tubing, the former problem of running tubing in a well with high gas pressure having been solved by the Otis method, whereby the tubing itself is run in under pressure, a special set of control valves being used. By flowing through tubing it is possible to secure the most economical gas-oil ratio.

The Production Committee of the Petroleum Division of the A.S.M.E. has in the past year made important contributions to the petroleum industry in preparing detailed reports on various tests of rotary drilling equipment, including "Steam Tests on Rotary Drilling Equipment on a Deep Well in the Oklahoma City Field," and "Tests on a Steam-Turbine-Driven Slush Pump on a Rotary Drilling Well at Perry, Oklahoma." These two tests were carried out under the personal supervision of Prof. W. H. Carson, of the University of Oklahoma, and are now being published in pamphlet form by the A.S.M.E. Both tests were made under actual drilling conditions, and equipment specially designed for the purpose made it possible to take indicator cards on a "runaway" steam engine at a speed above 500 r.p.m. This is the first time actual tests have been made on rotary drilling equipment in its ordinary use of drilling a deep well, and the results obtained afford the opportunity of such conclusions being drawn as will bring about changes in design of equipment.

The Production Committee has also completed a report on electrical rotary drilling. This report comprises an accumulation of data on several electrically drilled wells collected by various members of its Electrical Subcommittee, and gives actual time studies and drilling costs per foot with the equipment used. However, due to the fact there is no extensive standardization in sizes of equipment for electrical drilling, the subcommittee does not intend this report to be influential in bringing about changes in the design of equipment.

The Gas Engine and the Diesel Subcommittees have collected considerable data, but feel that drilling must be resumed more vigorously before a sufficient amount can be obtained.

The Counterbalance Subcommittee has been unable to do more than work out an outline to be used in taking data when development in the oil industry shall afford a chance to obtain them. The data that will be collected will undoubtedly serve as a guide

in the selection of proper counterbalance, which latter will result in more efficient pumping with less rod breakage.

The Production Committee has been hindered in the scope of its work by the conditions of proration and military rule in the fields in the Mid-Continent Section. In consequence of an almost complete shutdown of drilling, comparatively few changes have been brought about in this phase of the industry in the past year. The conditions with which the production engineers have had to contend in the past have been mainly those of time, and these have excluded to a great extent consideration of matters affecting the economy of drilling. This waste and extravagance will perhaps never be so pronounced again in production methods, and it is in this respect that the Committee, by its previous work and work yet to be carried out, hopes to have aided and to further aid the industry.

Petroleum Transportation[10]

During the past year the most marked progress in transporting crude oil and refined products has been in connection with station design and equipment, with particular reference to automatic controls.

Based upon the data and information worked out by the Automatic-Station Committee, two major pipe-line pumping stations have been built and are in constant operation. In these stations both the automatic equipments and the remote-signaling system have proved entirely successful commercially, and it is safe to predict that with renewed activities in the industry a number of additional stations will be installed based upon these principles.

On the Empire Pipe Line Company's line a pressure gage has been substituted for the flowmeter, and adjusted to stop the pumping equipment when the pressure on the discharge side reaches a predetermined low level.

An entirely new scheme for automatic pumping-station control has been developed and placed in successful operation. This control is based upon a volume-pressure differential.

A type of prime mover has recently been introduced into the pipe-line industry which is arousing much interest. This is the high-speed, light-weight Diesel engine. It is evident that this machine will furnish considerable competition for the electric motor since it is relatively light in weight, more reasonable in cost than the heavier Diesel engines, and very economical, in operation.

Present economic conditions have forced the pipe-line companies to realize that it is necessary to reduce operating costs of small gathering stations, and this can best be accomplished through the adoption of automatic controls, thus eliminating a large percentage of labor. Such automatic stations controlled through time switches and liquid-level controls have been in operation for several years, hence there is no question as to their commercial success.

Lubrication Engineering[11]

Proper application of the lubricants to existing machinery, including the design of lubricating systems, so as to avoid contamination of lubricating oil while it is in service is beginning to receive due attention. Research on the bearing metals, on the design of bearing surfaces, and on the character and specifications of the lubricants are of course all necessary and proper. But all the improvements that might result from these studies cannot secure the fullest practical results if the present contamination of the lubricants is allowed to continue.

In the study of contamination some progress has been made as to the abrasives found in used lubricating oil. Filters have been developed for many kinds of machines, and these are most effective when the filtering medium is clean. But as a rule perfection can only be approached when the filters are given constant attention, because often the contamination in the oil rapidly fills up the filter medium. There is still much to be desired in this development.

However, the study of the proper application and care of the lubricants in some forms of industrial and household machinery has now definitely brought about some excellent results. Certain household machines have been brought to such a high state of perfection in regard to the non-contamination of lubricant that they can operate over long periods of time without renewal of either lubricant or machine parts. In spite of these excellent examples, many kinds of machinery are continuing to operate or are being designed in such a way that the lubricant must carry contaminations of every nature back to the bearing surfaces, with a consequent high cost of renewal of lubricant and machine parts.

In an effort to eliminate this last extreme the Lubricating Engineering Committee of the Division is planning during the coming year to make a survey of the progress made during the last 25 years in the lubrication of the steam turbine. This survey, with others to be made later dealing with different machines, should bring out valuable information on the application of lubricants, the lack of which is causing present-day machines to be designed without regard to many early experiences that might prove beneficial.

[10] From section of report prepared by T. D. Williamson.

[11] From section of report prepared by William F. Parish.

The Printing Industries[1]

THE year 1931 has been one of deeper research and investigation into matters concerned with printing and in the making of the various units involved in present-day practice. It may be that the Second Conference of the Printing Industry held in Washington, D. C., in March had something to do with this, for while the papers there presented were excellent, discussion was unfortunately curtailed by lack of time. Noting this, the Third Conference, to be held in March, 1932, in New York City, will have a program in which there will be definite time allotments to permit pertinent discussion, to which discussers will be glad to conform.

Newspapers are giving much attention to color work; new multicolor web presses have been installed and are on order, and it would appear that in the near future newspapers will be run in colors as regular editions, both in the body and in the advertisements. Already some papers are running advertisements in colors in a manner somewhat limited but indicating that as fast as facilities are afforded the practice will spread. Discussion is still rife as regards the respective merits of stereotypes and electrotypes; mats are being sought that will take a sharper and smoother impress; stereotype metal is being analyzed to get uniformity of mixture and temper, all to the end that the stereo-

[1] The executive committee of the A.S.M.E. Printing Industries. Division, whose annual progress report is here presented, consists of Arthur C. Jewett, *Chairman*, Walter E. Wines, *Secretary*, Geo. C. Van Vechten *Vice-Chairman*, William C. Glass, and John Clyde Oswald. The original report was prepared by W. S. Huson.

type shall at least equal the electrotype. A marked departure from the usual practice in making a stereotype matrix by beating or rolling it into the form and then drying it on a steam table is found in a recently developed direct-pressure matrix press (Fig. 1). The form with matrix and blanket on it is prepared on the front apron, then passed on to an electrically heated bed directly under the heavy platen, and pressure applied automatically; an adjustable device relieves intense pressure, thereby allowing for expansion under heat. The upper platen makes the impression, and the lower platen or bed dries the matrix. By this method, it is said, a uniform pressure is exerted over the entire face of a form, and as the bed is heated by electrical heating units so placed as to afford an even distribution of heat, the matrix is thoroughly and rapidly dried. Used in conjunction with specially prepared matrices chemically treated and having a degree of plasticity, it is asserted that there is no difficulty in obtaining a perfect mold having a smooth, hard, glass-like surface which will be reproduced in the stereotype with characteristic halftone sharpness. With the view of avoiding distortion, a novel method of backing curved electrotyped shells is being worked out in which the copper shell is used as a mat in a curved mold, somewhat after the manner of casting a stereotype plate. It is claimed that by this method the mechanical curving of flat plates, with the incidence of distortion or stretch, is overcome, and that plates, say, for color work, can be produced which will be true

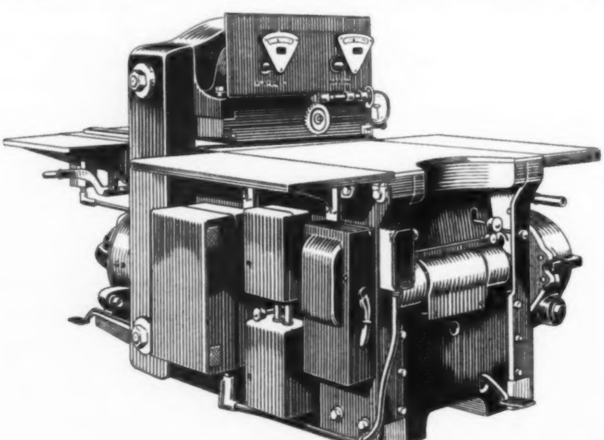

FIG. 1 DIRECT-PRESSURE MATRIX PRESS
(F. Wesel Manufacturing Co., Scranton, Pa.)

to register and of uniform face—something much to be desired. Hard-rubber plates, it may be mentioned, are coming to the fore, and color work has been printed from them with commendable results. It is said that they stand up for reasonably long runs, take kindly to ink, readily free themselves from dust, and that no chemical reaction is set up when they are used with colored ink. Other research is being extended to comprise certain synthetic compounds of which plates may be made, and this would appear to indicate that some material other than metal is being sought from which to make plates and which will give as sound or better results.

The deep-etch plate for offset work is being given intensive study and development to adapt it to finer grades of work; photolithography is evolving into every practical application. Examples of four-color work show remarkable advance in the character of the work; the dots are sharp impressions, clean and in register, and while the making of plates by photolithography may be considered to be only in an advanced formative stage, there is nevertheless intensive research going on abroad in the development of this method of plate production. Photogravure finds an impetus in its extending use. Alexander Murray[2] says: "In photogravure a very important development is the marked growth in England of printing from intaglio halftone on flexible copper sheets. This is an economical, rapid, and fine process whose importance is not yet recognized in this country, but it is likely eventually to supplant to a large extent the carbon-tissue process. Rotary photogravure in colors is gaining ground, the process now being worked at a machine speed of 7000 revolutions per hour of the printing cylinder." This leads to the consideration of printing by the Pantone process, which, although having its ups and downs, still persists and is being aggressively pursued in research work and laboratory with encouraging prospect for a successful outcome. It is probably the most radical departure to date in making printing plates, for while progress has been made in the familiar methods employed today and discussion as to the merits of this or that way for producing printing plates is prevalent, there is the persistent thought that planographic or surface printing will ultimately be the dominant means for producing printed matter. It may seem like history repeating itself to go back to lithography and claim that this primary method may in some future development be the leading means. Yet as the method has advanced from stone to metal plate through collotypy, offset, and gravure, the constant adaptations of photography and research in chemistry in the attraction and repulsion of elements that can be used in printing, for instance, the familiar oil-and-water feature of lithography, have done much to bring about its success. Speaking of surface printing, there is one form that has not had a place in the activities of the Printing Industries Division but should have, and that is textile printing, though the fabric involved is other than paper.

It must not be inferred that textile printing has stood still because some of the printing is yet being done on presses which have been running over eighty years. While improvements have been made, the method is essentially the same today as it was then.

It is this fact that there has not been more advancement that concerns textile printers, and that is spurring them on in an endeavor to find ways that will enable them to get still better results.

Here it is that the Printing Industries Division feels there is opportunity for comparison of experience, practice, and opinion that will be helpful and profitable, and broaden contacts that will redound to the benefit of both branches of the industry.

The copper printing cylinders or shells used in textile printing are etched from transfers or designs scratched through an acid resist by a pantograph machine, and photoengraving is also being tried. The material to be printed is supplied in the form of a web, or several colors are run in sequence and register. There is a system of blanketing peculiarly its own, yet having features that may at some time apply to other forms of printing in colors. These printing machines have been recently improved in details, made heavier, and strengthened. Fig. 2 shows a fourteen-color press; the large cylinder carries a blanket of several plies of thin fabric as a basic impression surface, and would seem to be turned by the large so-called star gear. However, this is not the case: the gear turns freely on its axle and drives the small gears on the printing cylinders, which in turn rotate the large impression cylinder by frictional contact. Goods up to 54 in. wide can be run, and in some machines, still wider. These machines have been adapted to printing carpets in sixteen or more colors, so there is a versatility in them as in other printing presses. Fig. 3 shows a row of machines in a print works in the South. The arrangement of the blanketing can be traced from the machine in the foreground; first is the goods being printed, then a so-termed "back-gray" blanket which receives the "offset" from the penetration of color

[2] Graphic Arts Research, Eastman Kodak Co., Rochester, N. Y.

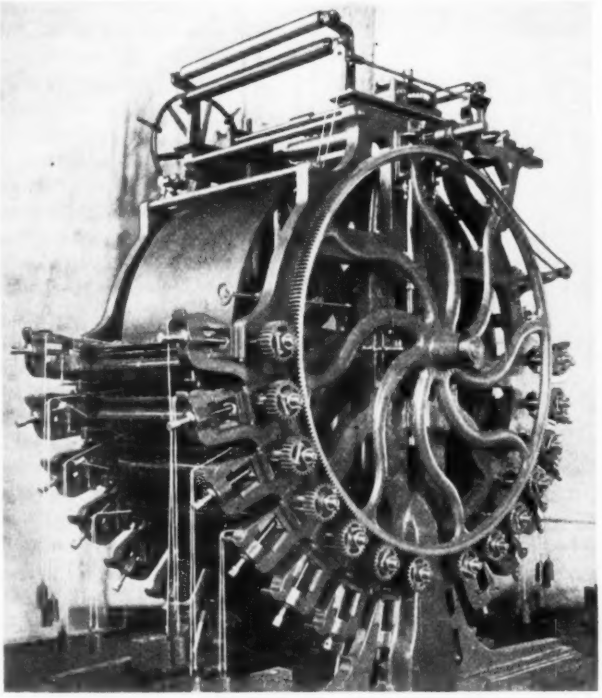

FIG. 2 FOURTEEN-COLOR TEXTILE PRINTING MACHINE
(The Textile Finishing Machinery Co., Providence, R. I.)

through the goods. This blanket resembles the offset web used on certain magazine rotary presses, being fed from a roll and rewound, and when soiled too much after repeated runs, cleansed in a blanket-washing machine. Under the back-gray there is a thick, endless blanket which requires removal only at long intervals. The blanket thicknesses permit a strong impingement of the printing cylinders, thus holding the designs to sharp definition on the goods.

A new type of single-revolution, two color, sheet-fed rotary press has just been brought out which has several excellent features. It will print sheets up to 50×72 in., and at speeds higher than those of any presses now extant for sheets so large and fed from a single feeder; in fact, it would seem to be the closest approach to the continuity of a web that has ever been devised. Fig. 4 shows the press in its entirety, sheets being fed from a pile feeder placed between the pile delivery at the right and the press feedboard. A sheet is taken by a feed-in cylinder, transferred to the first impression cylinder, then by a transfer cylinder to the second impression cylinder, thence to a delivery reel and over a slitter reel to a chain delivery which deposits the sheet on the pile delivery at the extreme end of the press. The plate cylinders are so disposed as to give ready accessibility for attaching plates, more than half of a cylinder surface being available. The gripper actions are gentle and positive for register, and the cylinders are tripped manually or automatically as in the case of a misfed sheet, yet if the second color is being printed on the previous sheet the operation will be completed and the device will not again function until there has been a first impression. When it is considered that the cylinders print a sheet on each revolution, that the sheets are fed one immediately after the other, that blank space on the cylinders is reduced to a minimum—which means slow surface speed, that the inking mechanisms are provided with every means for complete distribution, and among other things that the oiling system is equipped with the nested type of oil tubes, it would seem that the machine itself and the facilities for its operation are about the last work in completeness, speed, and quality of printing and construction for two-color flat-fed rotary presses.

Investigation into the merits of glossy printing ink for color work as compared with a flat effect continues and is the subject of lively discussion among printers. When water-color prints first came out they had an attraction of their own because of their very apparent contrast with gloss colors.

L. S. Allstrum[3] in commenting on this points out features that characterize the effects of each. The glare of a shiny subject confuses its detail, he says, because it deflects light, while a dull, flat surface is easy to see as it will more readily absorb light; therefore the eye will better accommodate itself to it, and dull colors are seen more nearly in their true shades. It is not unreasonable to say that much of the tendency toward eye weakness is due to strain from reading matter printed on glossy paper with glossy inks which vary in color shade at different angles, whereas "dullset" inks, now that they are made with oil as a vehicle, vie with water colors, with the added advantage claimed that there is

[3] Gen. Mgr., Geo. H. Morrill Division, General Printing Ink Corp., New York, N. Y.

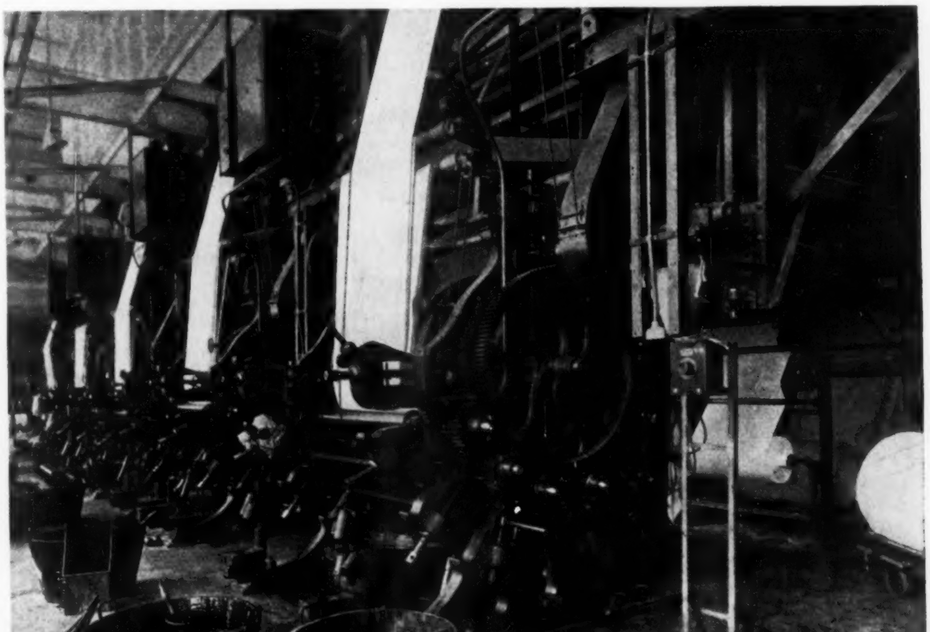

FIG. 3 INSTALLATION OF TEXTILE PRINTING MACHINES IN THE SOUTH
(The Textile Finishing Machinery, Co., Providence, R. I.)

less blending and more permanence. Glossy inks, however, are being made still glossier, so that it may be said there are two extremes which in their range can be adapted to make reading matter more readable and color work more beautiful to the eye.

Research work on the permanency of paper is steadily going on, and while confined more to the stock for records, newsprint may well be made better; for so essential is it considered that printed matter be preserved for posterity that special editions are being printed on special textile material at great expense for preservation in our great libraries.

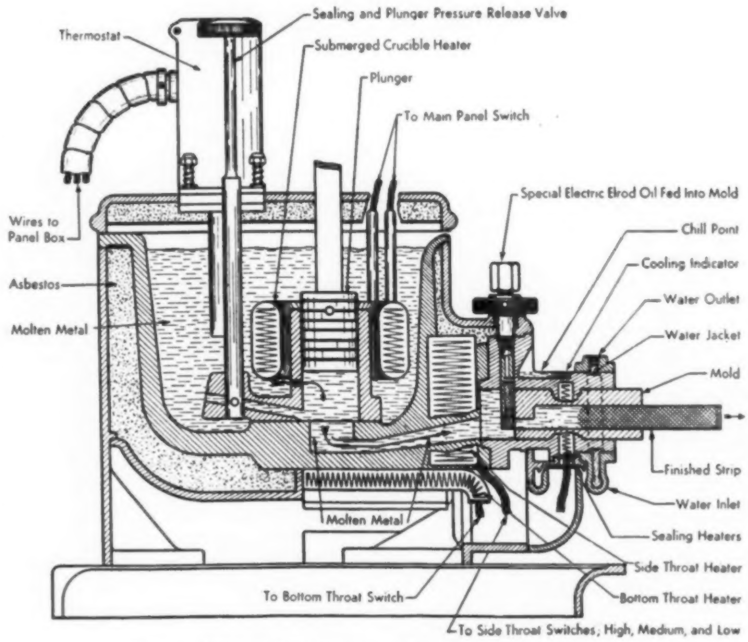

Fig. 5 "Elrod" Continuous Strip-Casting Machine
(Ludlow Typograph Co., Chicago, Ill.)

A novel adaptation of the electric heating coil is found in the "Elrod" continuous strip-casting machine shown in Fig. 5. The main coil being sunk in the molten type metal in the pot or crucible insures uniform heat at the middle of the melt, and as the metal is drawn from this point there is always a clean flow to the mold, from which it is extruded either as plain leads, rule, or other printing material that can be cast automatically as a strip which will be true to dimension and have a clean face. The extent to which electric coils have been adapted to the passages and throats and the general concept of the machine will appeal to others outside the printing field as being very complete in detail, efficient, and adaptable to various uses where metals are fused and can be pumped in a continuous stream to a mold or other final shaping device.

In concluding this report, it may be said that much encouragement is found in the cooperation of the personnel of the various branches of the printing industry, in the manner in which they have responded in a determined effort to aid in the further advancement of printing, not only as regards its engineering features but also its graphic arts side. Profiting by the experience of the first and second conferences, the third conference of technical experts in the printing industry, to be held in New York City, will be a decided advance, for in the hands of a committee of men aggressively concerned in all that applies to their work, a program of exceptional interest is being prepared which will appeal to those who will be fortunate enough to attend, no matter what their particular field may be. Detailed plans are taking shape and will be announced soon.

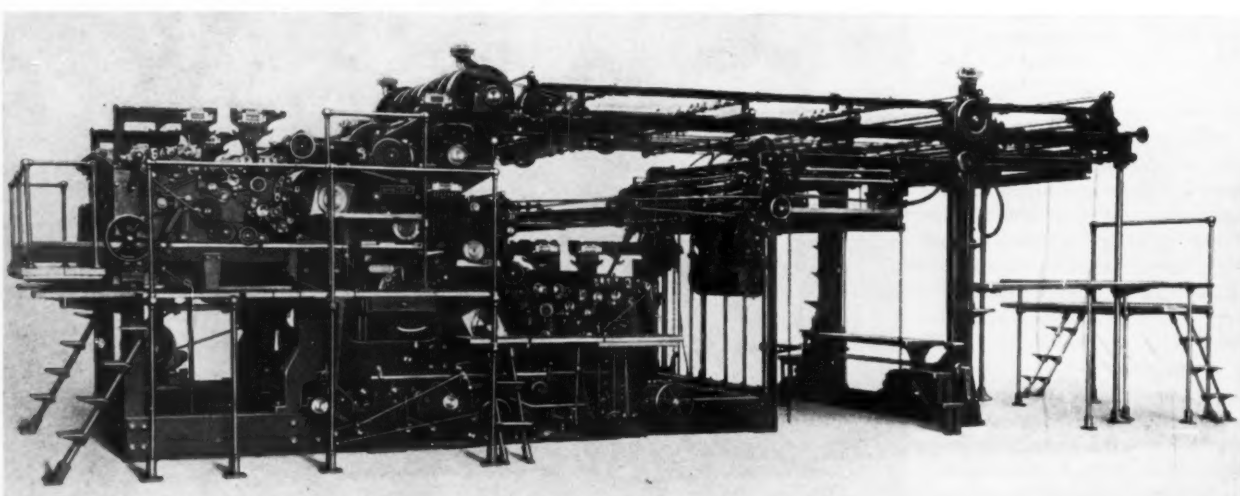

Fig. 4 Automatic Sheet-Fed, Two-Color Rotary Press
(The Babcock Printing Press Manufacturing Co., New London, Conn.)

Railroad Mechanical Engineering[1]

WHILE the railways have faced many problems in 1931 growing out of the world-wide depression of this and the previous year, they have nevertheless established several new high records of operating efficiency. Freight-Train Speed: monthly average for the first five months of 1931 was 14.5 m.p.h. compared with 13.5 m.p.h. during the same period of 1930, an increase of 7.4 per cent; Fuel Consumption, Freight: pounds per 1000 gross ton-miles for the first six months of 1931 was 122 compared with 125 in the corresponding period of 1930, an improvement of 2.4 per cent; Fuel Consumption, Passenger: pounds per passenger-train car-mile for the first six months of 1931 was 14.8 as compared with 15.0 for the same period of 1930, an improvement of 1.3 per cent; Gross Ton-Miles per Train-Hour: monthly average for first five months of 1931 was 26,354 compared with 24,242 during the like period of 1930, an increase of 8.7 per cent; Net Ton-Miles per Train-Hour: monthly average for first five months of 1931 was 10,850 compared with 10,331 in the corresponding period of 1930, an increase of 5.0 per cent.

With continuing improvement in train operation, including size of train, speed of transport, reliability of service, and longer runs, the railroads were never more efficiently operated than they have been during the current year.

The need of more present-day type of locomotives with their constantly increasing tractive capacities and built-in economy-producing features is ever more apparent. No more concrete evidence of the superior performance of the modern locomotive is to be had than that afforded by the results obtained during the present curtailment of traffic by those railroads which have been in a position to handle practically all trains with power of recent purchase.

Motive Power

The major developments of steam locomotives during the year have been two examples of high-pressure locomotives, hereafter described, and one two-cylinder simple locomotive, said to be the largest in the world. It cannot be stated, however, that the opportunities for increase in efficiency of railroad operation through improvements in locomotive design and construction have been exhausted, especially since locomotives built prior to about the year 1925 possess all the economy-producing factors that have been built into the greater percentage of locomotives acquired since that date. Increased boiler capacities and efficiency, increased mileage between shoppings, larger grate areas made possible by four-wheel trailer trucks, all have effected a marked improvement in combustion efficiency. The type E superheater has increased heat-transfer capacity within fixed limits of size, and it is stated that in eliminating a large number of heavily stressed bolt joints, cast-steel locomotive beds with integral cylinders have paved the way for further reductions in the cost of locomotive repairs. The articulated main rod, as applied to locomotives of great power, has also contributed to reduced machinery repairs. Tenders of 22,000 gal. capacity in 1919, have been made practical through the use of the one-piece cast-steel frame and water bottom. The larger tenders have proved important factors in operating economies through increased length of continuous runs and a reduction in the number of water stations to be built and maintained.

Modern metallurgy is providing constant and specific improvements in boiler plate, forgings, tires, wheels, bearings, and many other parts, and finally the roller bearing promises substantial relief in the problem of lubrication. The outstanding achievement of the year in connection with roller bearings, however, has been their application to the main driving and trailer journals, as well as to the engine truck, of a heavy modern locomotive, which shows promising results after several months of service.

Several locomotives have been constructed abroad with working pressures approximating 850 lb. per. sq. in., and recently one was completed carrying 1700 lb. per sq. in. It is stated by interests favorable to these locomotives that they promise high economy in the use of fuel and reasonable maintenance costs, and at the same time no difficulty has as yet been experienced with the use of water of the grade usually supplied to locomotives using lower pressures.

Two high-pressure locomotives have also been built on the American continent, one by the American Locomotive Company for the New York Central Railroad, and one by the Canadian Pacific Railway in its Angus shops. Both of these locomotives present radical departures from established practice of steam-locomotive design and construction, and their operation will be observed with great interest by railroad men throughout the world. These locomotives incorporate what in Europe is known as the Schmidt-Henschel double-pressure high-pressure system, and in America as the Elesco multi-pressure system. The fundamental principle consists of the utilization by a double-expansion engine of steam from a two-pressure boiler in which the high-pressure element receives its heat from a super high-pressure closed-cycle steam system.

Each of the two engines is of the three-cylinder type, the middle cylinders receiving superheated high-pressure steam at 850 lb. per sq. in., while the two outside low-pressure cylinders are supplied with a mixture of exhaust steam from the high-pressure cylinder and live superheated steam from the low-pressure boiler at 250 lb. per sq. in.

The steam-generating system is divided into three parts, viz., the closed super high-pressure indirect heat-transmission system, the indirectly heated high-pressure boiler (drum), and the low-pressure boiler. The closed circuit consists of a water-tube generator forming the walls and crown of a firebox connected into an arrangement of header drums and a firebox ring, also heat-transfer or condenser coils forming a part of the closed circuit located in the high-pressure drum. The steam passing through the heat-transfer coils is condensed as the result of giving up its latent heat to the water in the high-pressure drum, and is returned through downcomer tubes to the firebox ring, thus again being made available for recirculation. The high-pressure boiler drum is located directly above the firebox, but is insulated and receives no direct heat. The closed-circuit system, in which distilled water is used, operates at approximately 1350 lb. per sq. in. and the high-pressure boiler drum at 850 lb. per sq. in. The low-pressure section of the boiler consists of the barrel of a conventional firetube-type boiler, and operates at a pressure of 250 lb. per sq. in.

Following are the dimensions of the New York Central and Canadian Pacific locomotives:

	N. Y. C.	C. P. R.
Road No.	800	8000
Type	4–8–4	2–10–4
Class	HS-1A	T-4-A
Driving wheels	69 in.	63 in.
High-pressure cylinder (one)	$13^1/_4 \times 30$ in.	$15^1/_2 \times 28$ in.
Low-pressure cylinders (two)	23×30 in.	24×30 in.
Working steam pressure (high-pressure)	850 lb. per sq. in.	
Working steam pressure (low-pressure)	250 lb. per sq. in.	
Working steam pressure (closed circuit)	About 1350 lb. per sq. in.	

[1] The executive committee of the A.S.M.E. Railroad Division, whose annual progress report is here abstracted, consists of Eliot Sumner, *Chairman*, P. D. Mallay, *Secretary*, A. G. Trumbull, T. C. McBride, L. K. Sillcox, and C. B. Peck. The original report was prepared by A. G. Trumbull.

Cut-off (max.), high-pressure cylinder.....	86 per cent	80 per cent
Cut-off (max.), low-pressure cylinders.....	78 per cent	80 per cent
Tractive power..........................	66,000 lb.	90,000 lb.

Rolling Stock—Freight Cars

Of interest in connection with the design of freight cars, especially those ordered in 1930, are the large number which were built to A.R.A. standard dimensions and design. An analysis of the freight cars ordered during the past three years shows an increasing tendency to utilize the designs developed by the American Railway Association, Mechanical Division. This is particularly noticeable in respect of single- and double-sheathed box cars, for which designs were first adopted. Of further interest is the increase in the number of 65-ft. mill-type gondolas ordered, for which there appears to be increasing, although restricted, demand.

In the field of freight-car construction there is a noticeable tendency toward equipment of higher capacity and increased weight. Recognition of the fact that full advantage may not have been taken of recently developed methods of construction in order to produce weight reductions has been responsible for some recent notable examples of freight-car construction. One is the 70-ton hopper car built by the Pullman Car and Manufacturing Company for the Chicago Great Western Railroad. The weight of this car completed is 45,900 lb., or roughly about that of a 50-ton car of riveted construction. This means that twenty additional tons of coal can be carried in each car at no greater transportation expense for the movement of tare or dead weight. As compared with the heaviest 70-ton riveted hopper cars of recent design, the welded car weighs 10,500 lb. or 18.6 per cent less, and at the same time provides 85 cu. ft. or 3.1 per cent greater cubic capacity, all of which is available for carrying increased revenue load. As compared with the lightest riveted cars of recent construction, there is a decrease of 4300 lb. or 8.6 per cent in light weight, a notable reduction in view of the fact that a gain of 243 cu. ft. or 8.9 per cent in cubic capacity is effected at the same time.

This car is designed to take advantage of welding to tie in all members so that all parts of the underframe and superstructure act as a unit in resisting draft, buffing, and load stresses. Pressed shapes, with large radii at the corners, are used, these shapes lending themselves to the welded construction much better than the usual structural shapes, and having the additional advantage of light weight. When welded to the sheets, they form box sections of greater strength per unit of weight than the usual structural shapes used in riveted cars. Flanges are largely omitted, since they are not required for the application of rivets. The stakes are placed inside the car and the side sheets brought out to the line of the riveted car to get maximum capacity. All joints in the coal space are made with continuous welds, so that there are no openings to permit the entrance of moisture and dirt. In addition to this, the slope sheets are given a pitch of $1^1/_4$ in. from the sides toward the center, in order to drain water away from the corners where the corrosion takes place. This construction collects moisture at the center and at the same time assists in unloading.

The American Car and Foundry Company has also built for the Chesapeake & Ohio Railway five 50-ton gondola cars, each with a cast-steel underframe. This is a one-piece cast-steel construction, to which the superstructure, consisting of rolled steel shapes, plates, and bars, was welded. No rivets were used in the body of the car except for safety appliances, draft-gear carriers, pipe clamps, and badge plates. The weight of this car is approximately the same as that of a car of riveted construction, having A.R.A. center sills and side sills, which was built for the Chesapeake & Ohio in 1930. It is anticipated, however, that the new car will have a much longer life, increased serviceability, and substantially less maintenance than cars of the conventional construction.

One of the unusually interesting designs of the year has been that of a tank car in which the underframe and bottom course of the tank are made in a single steel casting.

A noteworthy event has been the installation of roller bearings on 100 Pennsylvania hopper cars. These cars are providing the first intensive service trial of roller-bearing equipment in freight service in North America.

Progress in development of various methods of refrigeration of perishables has arrived at the stage where commercial use is practical. However, the railroads have not as yet had occasion to take any position in regard to the methods, but it is to be presumed that they will accept any development which benefits the shipper and whose introduction is accomplished along sound, economical lines without unnecessary departures from existing practices, where such practices are fully satisfactory.

Rolling Stock—Passenger Cars

While passenger traffic continues to decline, the railroads generally have adopted measures for increased comfort and luxury of train travel. These measures have been devoted as much to providing greater comfort for day-coach and chair-car passengers as for sleeping- and parlor-car passengers. In fact, there has been a well-recognized effort to produce a striking contrast between the comforts of steam-railroad transportation as compared with other forms of travel which have been responsible for dwindling steam-railroad passenger business. Liberal expenditures have been made for new equipment, and in some instances for additional luxurious trains. Higher and higher standards of passenger-travel luxury are being attained each year.

The tendency toward the operation of passenger trains on much faster schedules has continued. The schedules formerly considered fast have been reduced as much as three hours over the longer distances. In some instances, the increased speed has proved a considerable factor in meeting coach and other competition.

Experiments with mechanical air cooling and air conditioning on passenger cars have been continued from last year, as a result of which several practical methods have been developed. Until comparatively recently, air conditioning and cooling have been confined to dining cars. The Baltimore & Ohio, however, has equipped the train known as the "Columbian," operated between New York and Washington, with an air-conditioning and cooling equipment designed by engineers of the railroad and the York Ice Machinery Corporation, of York, Pa. It is stated that the equipment used on the "Columbian" will permit ventilation of the coaches at controlled temperatures without admission of smoke or dust.

The Carrier Engineering Corporation also announces the development of a new application utilizing the absorption system. This employs steam for producing a vacuum and obtaining the cooling effect. Water is used as the refrigerant, thus avoiding any possibility of unpleasant consequences resulting from leakage in pipes, which are a necessary part of all compression systems.

Experiments in the conditioning of coaches and sleeping cars may be expected to continue, with the ultimate development of a reliable system which can be applied at a reasonable initial cost with a minimum cost of upkeep.

Railroad traffic, both passenger and freight, has witnessed a steady decline. The very great decrease in freight traffic may be attributed largely to business depression, although motor-truck competition has been a minor factor, especially for short-haul traffic.

Professional Services and Technical Training

The facilities of the various educational institutions continue to

be overtaxed by applicants for admission. There has been an increasing tendency to select graduates of these institutions with particular qualifications for service in certain industries, which should prove of mutual advantage. The American Railway Association continues in a greater degree the utilization of laboratory and test facilities afforded by the various educational institutions, especially Purdue University. An example of this work is the very important investigation being conducted by the Mechanical Division of the American Railway Association of the functions of air brakes for long trains. In addition to this, investigations are in progress covering automatic train-line connectors, and axles, as well as joint investigations of tank-car appliances and devices, these latter being made in cooperation with the American Petroleum Institute and the American Car Institute. In addition, an interesting example of the advantage of scientific investigation has been that of the test made of a thermic siphon by the University of Illinois.

The unprecedented economic situation, coupled with highway-transport competition, has prompted an appeal to railroad men from various directions to maintain a receptive attitude toward new ideas and a willingness, if necessary, to violate all precedents in order that the railroads may successfully meet the new conditions with which they are confronted. The railroads have been openly charged in the newspapers with negligence in failing to develop light-weight equipment with operating speeds up to 150 miles per hour, such, according to reports, are now being obtained with Zeppelin-propelled rail cars recently developed in Germany. These developments have been viewed with increasing interest and are cited only as indicating the necessity for close observation of current developments that are everywhere in progress. Past experience has shown that practically every vital improvement in railroad operation has been first looked upon both with skepticism and distrust.

Development Work on the German National Railways[2]

The German National Railways have in recent years suffered more than most other railways from the prevalent depression, as their returns form the chief part of the reparations so often discussed in the press of all nations. Apart from this continuous drain, Germany suffers more than any other nation from the general depression, but so far the front against Russian Bolshevism has been held successfully, though at a high price, As far as the inner life of the country is concerned, motor-car competition has been the dominating factor determining railway policy in many ways. In Germany, as in most other countries, inadequate legislation permits highway carriers to transport the most valuable freight from house to house without any obligation to transport low-grade, low-value freight as well. Though a motor-car and lorry tax is levied, its return is only a small fraction of the outlay required for road maintenance, the raising of the remainder being left to the taxpayer.

These conditions have naturally interfered seriously with railway development. The program for raising the wheel pressure on all trunk lines to 10 tons has, along with other development work, been temporarily abandoned. This fact and the demand for running a greater number of smaller trains to meet highway competition has made necessary the building of a light though powerful type of high-speed passenger locomotive.

This locomotive is of the Pacific type, with 53 tons weight on drivers, 2200 boiler hp., 227 lb. boiler pressure, and two single-expansion steam cylinders. It is scheduled to haul a 500-ton train at a speed of from 70 to 75 m.p.h. Three locomotives were ordered in 1930, and as they gave satisfactory results, 66 more have been ordered this year.

Considerable development has taken place in the construction of electric locomotives. The increased mileage of electrified lines in southern Bavaria and the scrapping of some of the oldest single-phase locomotives gave the occasion for putting into service a number of high-speed passenger locomotives. As the final lines of development are not yet quite defined, two competing designs were chosen. One of these was designed and built entirely by the A.E.G. The wheel arrangement is 2-8-2. The drivers are equipped with two motors each, driving over spur-gear hollow jackshafts surrounding the axles. With these they are elastically coupled by means of the usual Westinghouse-A.E.G. spring arrangement. All driven axles are located in the main frame, the outside drivers having a sliding suspension and being connected with the radial end wheels by means of Krauss-Holmholtz trucks. The weight on the drivers, which are 63 in. in diameter, is 80 tons. The maximum speed is 70 m.p.h. and the tractive effort is 53,000 lb. The competing type of locomotive was developed jointly by Messrs. Siemens-Schuckert and Borsig. This type has been developed in two different wheel arrangements: with all driven wheels located in one rigid frame, and alternatively with a flexible wheelbase. The wheel arrangement is also 2-8-2, but is divided between two trucks joined up by a central coupling pin. Each driver is equipped with a motor of the street-railway type, one-half of its weight being carried on the axle. The trailer wheels are arranged in Bissel trucks suspended in each individual main truck. The weight on the drivers, which are 55 in. in diameter, is 76 tons, the maximum speed, 70 m.p.h., and the tractive effort, 43,000 lb.

The novel tendency of competing with the motor car by emulating some of its peculiarities has led the way to an increased use of rail motor cars. On electrified lines eight-wheeled trolley cars have been put into service. Two motors, each driving one of the bogie-truck wheel sets, allow the car to attain a speed of 63 m.p.h.

On the steam lines, the existing types of rail cars equipped with 150-hp. Diesel engines have been improved in many respects, and several of them have been put into local passenger service, either replacing steam trains or filling intervals between trains.

A novel type of car has been designed and built for speeding up the collecting and delivering of freight parcels and packages. This car is designed to stop at all stations between consecutive yards where trains are made up. This will allow trains carrying mixed freight to skip all minor stations. By using high speed, the delivery of this type of freight, which otherwise travels slowly, can be made as promptly as it can by "door-to-door" road service. The freight rail car is an eight-wheeled car with two trucks, one of which is the engine truck. A 150-hp. Diesel engine drives a jackshaft through drivers of the truck by means of side rods. The car weighs 39 tons, its loading capacity is 15 tons, and its maximum speed is 44 m.p.h.

The Passenger-Car Department has also brought out a new type of eight-wheeled vestibule coach with a central aisle, whose trucks have an extremely light frame and a novel arrangement of long springs supporting the cradle. The strong damping influence of these laminated springs, which are made of steel $^5/_8$ in. thick, produces very smooth riding.

The Freight-Car Department has developed two promising type of cars for special freight. One grain car has been designed for special service from silo to silo or from silo to harbor. Its capacity is 55 tons of grain (cubic contents, 2750 cu. ft.). Four pairs of wheels are arranged underneath the main frame in two groups. No bogie trucks are used, as they would contribute unnecessary weight. Each wheel pair swings loosely in its spring hanger, so that a moderate lateral and radial motion is obtained. This wheel arrangement has become German standard practice for heavy eight-wheeled freight cars and gives complete satisfaction.

[2] By Dr. R. P. Wagner, Berlin.

Steam-Power Engineering[1]

BUSINESS conditions in 1931 have reduced the output, or at least curtailed the normal increase in output, in the majority of American power plants, both public-utility and industrial. Therefore there has been relatively little new construction. In spite of this unfavorable circumstance, the committee can report an unusual number of items showing definite progress in power-plant design.

Pressure and Temperature. The year 1931 has been marked by the initial operation of power-generating equipment utilizing the highest steam pressure and the highest steam temperature so far attempted in this country, and probably the outstanding recent development is a widespread increase of throttle steam temperature. While we have predicted this increase in several previous reports, 750 deg. fahr. had remained the commercial limit. At least one station is now in operation designed for a maximum operating temperature of 850 deg. fahr. Others are under construction, or projected, to operate at 825 to 850 deg. fahr. Two mercury-vapor installations now under construction will operate at temperatures in excess of 900 deg. fahr. Two years ago we reported the projected installation, in this country, of a turbine to operate at 1000 deg. fahr. The unit, installed by a public utility and designed for this temperature, is now in operation. The operating temperature is being gradually worked up to the specified condition. An industrial plant started operation this year, using the highest steam pressure yet used in this country, namely, 1800 lb. gage, and a critical-pressure boiler has been tested at one of the universities at pressures varying from 1500 to 3600 lb., and will be reported upon in a paper to be presented at a Power Division session at the Annual Meeting. An American boiler manufacturer has also operated a coil-tube boiler, experimentally, at 3500 lb. pressure. However, 400–460 lb. remains the most popular operating-pressure range, and there appears to be a definite trend toward the use of moderately high pressure, with high temperature, and without reheat. Turbine manufacturers are prepared to furnish turbines for operation at 1200 lb. and 1000 deg. fahr., but most designers regard 850 deg. as the maximum temperature now commercially practicable, and therefore 650–700 lb. is considered the maximum practicable throttle pressure for condensing turbines without reheat. Installations are under way or projected to operate at about 650 lb. and 825 deg. fahr.

Mercury Vapor. After several years of relative inactivity, during which details of design and operation have been studied, there has been a sudden increase of interest in mercury vapor as a power-generating medium. Two installations, each of 20,000 kw. capacity, are under construction. There is marked interest abroad in other binary-vapor cycles.

Diphenyl Oxide. Diphenyl oxide was advocated several years ago as a substitute for mercury in a binary-vapor cycle. There has been no commercial development along this line, but a notable installation has been made using this fluid for air heating. Diphenyl oxide, mixed with naphthalene to keep it liquid at moderate temperatures, is circulated through an economizer, where it is heated by flue gases, and then through a preheater, where the heat is absorbed by the air of combustion. This arrangement eliminates awkward and expensive duct work, and leakage from air passages to flues. It has been entirely successful in operation. The use of diphenyl oxide is being widely considered for industrial purposes, where it would replace direct firing or electric heating.

Availability. The N.E.L.A. Prime Movers Committee continues to report gratifying improvement in the availability factor for large turbines; the average outage for last year was 9.17 per cent, the lowest yet reported.

Fuel Economy. The downward trend of heat consumption per net kilowatt-hour continues. There has been an increased use of waste materials for fuel, and a notable improvement in the methods of using them. There has been marked improvement in the economy of relatively small turbine generators, although American manufacturers appear to be lagging behind certain foreign competitors in this field. Activity in natural-gas-pipe-line construction, together with state regulations to prevent waste of gas, have increased the use of this fuel for power generation. Overproduction of oil and the high freight rates on coal have combined to cause the conversion of numerous power plants from coal to oil. These conditions and the abnormally low prices of steam coal at the mines have resulted in exceptionally low generating costs during the current year. This has reemphasized the increasing relative importance of low capital expenditures in power-plant construction, but does not seem to have retarded the effort to obtain lower and lower heat rates.

Boilers and Furnaces. After several years of careful consideration, the Boiler Code Committee has approved the use of fusion welding for the construction of power boilers. The U. S. Navy purchased several boilers so constructed before the revision of the code. There have been two notable installations of high-pressure single-pass boilers in this country, and one abroad. These boilers are of the cross-drum type with one set of headers vertical and the other inclined, presenting a diminishing area to the passage of cooling flue gases. This type of boiler is particularly designed for low draft loss, and in one American installation the total drop from furnace to economizer outlet is less than two inches of water. Other single-pass boilers have been installed in which the headers are parallel, as in the more usual multi-pass construction. Much trouble has been experienced with furnace bottoms of slag-tap furnaces as originally designed. Many new designs have been developed. The modern combination of high pressures and high ratings has turned attention to improved circulation, in order to keep down the skin temperature of tubes, and the most recent designs of sectional-header boilers show materially increased output per section; this is accomplished by raising the drums and increasing the static head in the cold leg of the circulating system. One of the notable commercial developments of the year has been the merging of several manufacturers of separate items of equipment into a few combinations, each of which can furnish complete steam-generating equipment.

Fuel-Burning Equipment. In last year's report we noted an increased use of unit pulverizers in central stations. This trend continues, but there is also some indication of increased use of underfeed stokers; improved efficiency and increased capacity have made the use of stokers feasible in some very large installations. One stoker installation, now in progress, will be 69 tuyères long; the guaranteed maximum output of the boiler is 530,000 lb. of steam per hour. There have been material improvements in the power-transmission arrangements of stokers, and the above-mentioned large stoker is driven electrohydraulically, the transmission having a coal-feeding range of more than 30 to 1. Coal-pulverizing mills of increased capacity have also been developed; one mill of 50 tons per hour capacity is in successful operation, and several have been installed having capacities in excess of 25 tons per hour. Centralized forced-feed lubrication for large pulverizing mills is one notable development of the

[1] The executive Committee of the A.S.M.E. Power Division, whose annual progress report is here abstracted, consists of W. F. Ryan, *Chairman*, Arthur E. Grunert, *Secretary*, V. M. Frost, Alfred Iddles, and C. S. Gladden.

year. One large industrial plant has gone into operation this year in which the method of burning crushed coal in suspension is used exclusively and with reported success. Exception has been taken to the statement in last year's report in regard to the unsatisfactory range of burners for gas and oil; this statement is undoubtedly correct so far as it affects pulverized-coal burners, but burners are now available for gas and oil with an extremely wide range of capacity. The extreme rates of heat liberation which were essayed in a few installations some years ago, have not been continued. The trend, however, is conservatively upward, and continuous operation of a slag-tap furnace at 36,000 B.t.u. per cu. ft. per hour has been reported.

Superheaters. There have been no outstanding developments in superheaters during the current year, but a very valuable report was made in a paper presented by the Power Division giving operating experiences with radiant-heat superheaters. Recent studies on this type of equipment indicate that a revision of the Boiler Code may be desirable to permit construction which strikes a better balance between pressure stress and temperature stress. There is no definite trend discernible in regard to location of superheaters, division of surface between convection and radiant superheaters, or in methods of temperature controls. Many ingenious devices for temperature control have been developed, the most popular at the moment being the use of a desuperheater in series with the superheater.

Economizers and Air Preheaters. There have been no noteworthy developments in regard to this equipment, this year, except the use of a diphenyl oxide economizer for air preheating, mentioned above. Almost every boiler recently installed is equipped with an economizer, an air preheater, or both. There continues to be a wide diversity of opinion in regard to the proper distribution of heating surface between these two forms of heat trap and the main boiler. Continuous tubes with welded return bends, and fin tubes are relatively new developments in economizer construction. Rotating economizers, in which the tube bank rotates in the flue gases, have been installed in several foreign plants. It is claimed that a considerable amount of feedwater heating can be obtained without increase in draft loss.

Boiler-Feed Pumps. The boiler-feed pump has been the most troublesome item of equipment in many high-pressure plants. There has been a decided improvement in the general reliability of this important auxiliary. One 1400-lb. plant with two stages of feedwater pumping reports no outage whatever on the three primary pumps, and a total outage of 49 hours on three secondary pumps, in six months' operation. Two high-pressure plants, one a public utility, are using reciprocating pumps for feeding the boilers.

Condensate and Drip Pumps. Multi-stage condensate pumps have been developed which have operated successfully against discharge heads in excess of 400 ft. Drip pumps, used with stage heaters, continue to be troublesome in many plants, due to the small quantities of water, high temperatures, and high discharge heads.

Feedwater Heaters. There have been at least two installations, using the regenerative cycle, in which the feedwater has been heated in open or direct contact heaters. Completely successful operation is reported. Closed heaters have been furnished which are guaranteed to raise the temperature of feedwater, in the higher stages, to temperatures above the saturation point of the bled steam.

Evaporators. Distillation of raw water for make-up continues to be the general practice in central stations, when the quantity of make-up is relatively small. One American industrial plant has installed a ten-effect feedwater evaporator having a capacity in excess of 100,000 lb. per hour. A foreign industrial plant has installed equipment capable of furnishing 1,000,000 lb. of distilled water per hour. Evaporator condensers continue to be used for supplying process steam from high-back-pressure turbines, in order to avoid treatment of large quantities of make-up; however, the serious reduction in power output per unit of steam flow which this entails, and recent improvements in methods of feedwater treatment, have tended to reduce the use of this kind of equipment. Welded construction is more generally used for evaporators, and there is a growing use of seamless or hammer-welded tubes for evaporator shells.

Turbine Generators. There continues to be a great diversity in the arrangement of large units, single-barreled machines, tandem-compound, cross-compound, and steeple-compound having all been used under apparently like conditions. The outstanding development in the field of prime movers is, perhaps, the increasing use of high speed for relatively large machines. Six units of 10,000 kw. capacity and five of 15,000 kw. capacity have been installed to operate at 3600 r.p.m. Three of the 15,000-kw. units are non-condensing machines. American manufacturers are prepared to build 3600-r.p.m. units in sizes up to 20,000 to 25,000 kw. In Europe much larger machines are in operation at 3000 r.p.m., including one 50,000-kw., and one 60-000-kw. unit. Much greater attention has been paid to high efficiency for small units abroad than in this country, Compounding has been used in England on machines of less than 20,000 kw. capacity, and overall Rankine efficiencies of 80 per cent are reported for machines as small as 3000 kw.

Condensers. There is an increased use of welded-plate construction for condenser shells, and the rolling of condenser tubes solidly into the tube sheets is more common. For many years 1-in. tubes have been most widely used, but there is a trend toward smaller sizes, and many recent installations have $^7/_8$-in. tubes. The single-pass condenser still retains its popularity. Research on condenser-tube corrosion continues, but this problem remains as one of the most troublesome in power-plant operation. Arsenical copper is a new alloy for which unusual corrosion-resisting properties are claimed. An inverted type of condenser is in use abroad, in which the exhaust steam goes between baffles directly to the bottom of the shell, and then rises through the cooling surface; the air-pump suctions are at the top of the shell. Operation of steam-jet vacuum pumps at full boiler pressure is a new development which has been welcomed by power-plant operators.

Out-of Door Construction. Two out-of-door stations are under construction, in one of which the boilers are unhoused and in the other the main generating units will be out of doors.

Piping. The use of welded pipe is increasing, as noted in previous reports. Valuable research work has been performed, and reported upon in a paper before the Power Division, on corrugated and creased piping designed to increase the flexibility of high-pressure steam connections. This special pipe construction has been extensively used, particularly in industrial plants. During the past few years there has been much study of pipe-line flexibility from a purely mathematical point of view; substitution of scientific principles for rules of thumb has led to greatly improved design of piping systems, and leakage at pipe joints is now most unusual in well-designed plants.

Research. One technical journal, in a special research number, has reported several hundred individual projects of research or experimentation now under way. A symposium on metals for high-temperature work was held this year, the results of which have added materially to available data. Designers of power machinery are no longer waiting for a magic alloy which, at 1000 deg. fahr., will behave in the same manner as carbon steel does at 500 deg. They realize that creep will probably take place at high temperature with any metal that can be provided, and are designing their equipment to allow for this creep.

The Textile Industry[1]

NOTWITHSTANDING the existing depression and the fact that industry as a whole has been materially retarded, both as to production and development of new ideas, the textile industry has apparently made very considerable progress in the solution of industrial problems and in the development of machinery for its many processes.

Unlike other industries, the textile industry is divided into what might almost be termed cooperative branches, each with its own particular problems, although in a general way coordinated by construction and cooperative policies.

In the cotton and woolen industries marked progress has been made in the development of mechanism and processes which tend to simplify the work of production by eliminating wasteful operations and instituting methods for better control of manufacturing the product.

In the silk and rayon industries, which are so closely allied, much study has been given to the development along the lines shown by research.

In the knit-goods and the finishing industries there has perhaps been more decided improvement than in any of the other coordinates, and in the finishing industry especially there has been developed a mechanism—described in this report—which is perhaps the farthest-reaching development made in many years in the textile industry.

Cotton

Considerable development has taken place and improved mechanism has been introduced in the cotton industry, and this is particularly noticeable in the handling of the carding and warp-manufacturing machinery, together with the control mechanism for this particular operation.

High-speed looms both for the manufacturing of cotton and worsted fabrics have added much to the already well-developed loom industry. These new looms contain many novel mechanical refinements, and their operation apparently is smoother and more uniform than that of the older type; and the fact that the new box loom permits the running of several colors at high speed makes it one of the outstanding developments.

A new automatic loom incorporating a number of important improvements has been announced; among the advantages claimed for this loom it is the ability to weave full 41-in. goods on a 40-in. loom. It is possible also to use larger rolls of cloth, a larger yarn beam, and larger shuttles than could be employed with previous models. The new loom has been designed to run at a high speed, and it is stated that two mill installations for tests are running successfully at 190 to 200 picks per minute.

A high-speed rotary-traverse winder adapted for winding either cones or tubes, and particularly distinguished by the fact that it has no reciprocating parts for traversing the yarn lengthwise of the package, was announced early this year. It is stated that as a result of this arrangement there is no perceptible friction or strain imposed on the yarn by the traversing means, and it is possible, therefore, to run the machine at an exceptionally high speed.

Maintenance of stabilized atmospheric conditions at any predetermined standard is said to be made possible with an air-circulating system, which maintains a constant relative humidity in the opener and picker rooms, controls the regain of the stock as it passes through the primary stages of manufacture, and accomplishes this with relatively inexpensive equipment and simple layout.

In England an important development in the inclined mule spindle ring frame has been noted. It is stated that this equipment eliminates the drag during winding which limits the fineness and softness of yarn spun on the usual spring frame. In this country there is some skepticism regarding the importance of this invention as far as present ring spinning is concerned.

Another development, of German origin, is a compound drafting spinning frame. Its outstanding feature is that there are two sets of drafting rollers, between which is inserted a small twist tube for the purpose of condensing the strand and presenting it to the second set of drafting rollers in suitable form. The second drawing series is designed as a high-drafting unit, and either the Casablancas apron-drafting unit or one of the well-known pull-through roller-drafting devices and the three-roller type may be used. It is stated that drafts of from 40 to 400 may be used, depending upon the length and uniformity of the cotton staple.

A combination warping and gassing equipment for handling either balled or beamed warps has been brought out during the year. This machine has been designed to minimize the possibility of undersinged or burned yarn. The burner action is automatically controlled through the starting lever of the machine, and provides one bottom plane and one top plane for the sheet of yarn.

Another yarn-gassing machine, of French origin, is distinguished by the use of specially insulated burners, which are designed to prevent loss of heat by radiation and conductivity, and at the same time to concentrate the heat on the yarn.

In Italy a yardage-measuring stop motion for cotton roving frames has been brought out. This device permits stopping of the roving frames at any predetermined number of yards on the finished bobbin.

A slasher press roll is being introduced which is designed to reduce the number of loom stops, giving less variation in picks, and eliminate weaviness in woven fabrics, whereby the press roll can be raised or lowered so as to bring it in line with the barrel of the beam when friction is applied.

Card-clothing foundation of an improved design was placed on the market late last year; the most important difference between this foundation and the type commonly used is in the ply of linen which has a cotton warp. This construction has been adapted to support the warp and to give greater tensile strength than is possible with fabric foundation formed by a series of linen cords extending lengthwise of the fabric and secured side by side by cementing the cords together.

An automatic-take-up screw joint has been applied to steel spinning rolls. This type of joint is said to have many advantages for front rolls. With it, buckling or distortion of the roll is impossible, since all thrust and torque are taken by the substantial thrust collar which is an integral part of the roll.

The development of the continuous stripper roll has caused the systems of vacuum stripping now in general use to become obsolete. No longer need a card be stopped for stripping, and waste of material is also eliminated.

Wool

There has not been perhaps as much advance made in the woolen branch of the industry during the past year as in some of the other branches, still many new textile devices have appeared which have for their purpose the minimizing of labor,

[1] The executive committee of the A.S.M.E. Textile Division, whose annual progress report is here abstracted, consists of Paul A. Merriam, *Chairman*, Henry M. Burke, *Vice-Chairman*, M. A. Goldrick, Jr., *Secretary*, and Clifford H. Ramsey, H. V. W. Scott, W. L. Conrad. The original report was prepared by W. L. Conrad.

increasing the production, and improving the quality of the product.

Prominent among these are the new scouring bowls used in one of the methods recently introduced for treating the wool in the scouring operations. This mechanism, it is believed, has been used more extensively in Europe than in America up to the present time, and its operation is better understood there.

A new invention has made its appearance in the form of a machine to unravel woolen rags at a high rate of speed. It is claimed that this mechanism will very materially increase the product in this particular line.

Early this year a high-speed automatic worsted loom, having a practical speed range of 130 to 160 picks per minute, was announced. This loom was originally designed for the manufacture of tropical worsted in the 8- to 10-oz. class, but has been found to be capable of handling some classes of work ranging from 4 oz. to 20 oz. Test indicates that at least six looms can be run to a weaver, and 24 to 32 to a fixer's section. It is a 4 × 1 box loom of light weight and simplified construction, and embodies a number of improvements over earlier models.

A number of improvements have been made in a woolen card which was first brought out somewhat over a year ago. The most interesting feature of this card is the use of small-diameter cylinders. The small cylinder affords evenness of web, yet gives the same amount of carding as usual as the card speed does not vary greatly from that of a 60-in.-diameter card. It is stated that the card gives high production, an even web, a high yield per pound of stock, eliminates practically all stripping, requires small floor space, and entails low labor cost and low maintenance cost.

A new type of card clothing designed to prevent the formation of card strips has been developed this year in Czechoslovakia. In the manufacture of this card, the main cylinder, doffer, and rollers are first mounted and then are metallized by means of a foil of special alloy, which is passed through the staples with the aid of a thrusting device. In order to insure card staple of standard type, a slightly thinner felt than usual is employed with this new card clothing. The metal foil together with the rolled felt layer is only $1^1/_3$ mm. thick, and therefore, it is stated, there is no necessity for introducing appreciable changes in card manufacture.

Several unique features are embodied in a tape condenser brought out early this year and which is of the shallow-groove, thrower-bank, single-apron type. It is stated that, as a rule, the condenser allows 60 to 140 ends from 48-in. cards and 80 to 160 ends from 60-in. cards according to range of sizes and quality of the stock used.

Finishing Plants

Notwithstanding the existing depression, considerable progress has been made during the present year in improving conditions and processes in the cotton-finishing industry.

The introduction of the continuous process in bleach houses a few years ago has without doubt been the cause for much study and research, and the introduction of new and up-to-date methods in this section of the textile industry.

Perhaps the most important and far reaching of these improvements has been the development of the Sanforizing machines and methods widely discussed during the past year. The latest developments in these machines permit control of the shrinkage of both the warp and filling of the fabric, which is considered to be a very important forward step.

Another outstanding development is a new flame compression singer which was brought out this year. These burners trap the flame between the burner casting and the cloth, and as the result of the air having been previously mixed with the gas, complete combustion is secured without the addition of secondary air. Two such burners will do the work of five copper plates, and the machine is much simpler and easier to maintain and the fuel consumption decidedly less. The first installation of these flame compression burners was made last January, and since that time it is understood that installations have been made in twenty additional plants, showing that the improvement is being very generally accepted.

Another development of signal importance has been a jig which has been devised for use in the finishing industry and which apparently is most successful in eliminating many of the difficulties so common in the older type of jigs; the bars are adjustable and reversible, and the driving mechanism is of a decided novel nature.

An improved method for treating fabrics composed wholly or in part of rayon or other synthetic fibers was announced this spring. The process is said to eliminate the harsh feel, high luster, and speckled face characteristic of many fabrics of this type, and to impart a soft, mellow handle which more nearly resembles that of real silk. The method for producing this improved appearance in handle consists in permeating the fabric with steam at a suitable pressure and temperature, and thereafter cooling the fabric and withdrawing the steam by forcing air through the goods. Equipment for producing this effect has also been developed.

A new type of finishing machine for tubular knit fabrics has been devised which subjects the fabric to a sponging, shrinks it, puts on the finish by pressing the goods under hot paper, and delivers a finished package. In finishing tubular fabrics with this machine, the goods are passed over a superheated steaming cylinder of large diameter, are picked up and conveyed through a smoothing operation by means of a sheet of thin glazed paper, which acts as an apron, and are then rolled automatically in the paper.

Another finishing machine for tubular knit fabrics has been brought out which insures accurate control of both the width and length of the fabric during its progress through the machine.

Application of the counterflow principle to bleach-house or print-works washers is a development which is said to enable a water saving ot 50 to 75 per cent and at the same time permit more thorough washing and cleansing than is obtained with ordinary types of equipment. This method is now available on both the slack- and tight-strand types of machine.

Another cloth washer, designed primarily for use in woolen and worsted mills, although only 2 ft. longer than the older models, is said to have nearly twice the capacity of the old machine. In this equipment the shape of the tub has been changed to allow the cloth to open and remain in looser folds. Other improvements embodied are a level-control drain, a non-leaking suds box with two-way valves, a sheet-spray manifold, unloading roll, and improved pressure device with nip-opening arrangement.

A new type of extractor for tubular knit goods was announced early this year. This machine is equipped with a so-called "propeller spreader," which is made up to 12 driven rolls which propel the cloth through the machine. This device permits the fabric to be spread evenly to any desired width. Goods extracted on this machine pass over the spreader and through a pair of squeeze rolls which force the excess water out of the fabric, and finally to the drier.

An improved vacuum extractor originally designed for extracting velvet and corduroys, has been adapted for the removal of moisture from sheer fabrics of silk, rayon, and cotton. This equipment has a slot-closing device which adapts the machine for the reception of cloth in varying widths. It is also equipped with a variable-speed conveyor drive in order to permit synchronism with other machines operating in range.

A finishing machine for axminsters consists of a friction let-off back-sizing unit, which sizes the carpet in the usual manner, a steam box which steams the back of the carpet under pressure, and a large copper cylinder which not only dries the carpet but stretches and irons it as the same time.

A development in textile-printing machines is a new gear system. This improved system is designed to eliminate the handling of star gears, which have to be changed to suit the various sizes of printing rollers. The system consists of a series of small intermediate gears of laminated construction to minimize noise, all mounted on a segment framework which can be swiveled about the center of the star gear. The mesh between these small gears and the star gear is always correct and presents no additional hazard since it is completely guarded. As the print rollers are changed in size, these intermediate gears can be brought into mesh with the fitting gears on the mandrels simply by rotating the gear frame.

A full-width print washer and drier embodying a number of improvements was brought out this spring. While the machine was designed primarily for light qualities of printed silks, it is said that it handles rayon equally well.

A portable instrument for determining the air permeability of fabrics has been developed, and tests have been made on garments for under and outer wear and on parachute cloth.

Dyehouse Machinery

Waste-heat reclaimers operating on a new method are now available for recovering the heat lost from dry-can vapor and from ager exhaust. This is a decided step in advance in this particular process.

A new skein-dyeing machine which is recommended particularly for the application of vat colors to silk, cotton, and rayon was shown at one of the recent textile-machinery shows. It operates on the principle of the movement of both yarn and liquor. The movement of the yarn, however, is very slight, being only enough to shift the position occasionally to insure uniform action. On the other hand, the movement of the liquor is very great, the entire bath passing through the yarn under low pressure once each minute.

Silk

Two new looms designed especially for the manufacturing of silk fabrics have been brought out within the year. One of these is equipped with a take-up, and whenever the loom is started because of filling breaks, the pick is beaten in, and the take-up operates without any chance of a starting mark. The other loom is designed for making heavy weaves. It is of heavier construction than most silk looms and is quite deep, thus affording more harness space and permitting more warp stretch, which latter is valuable to mills making heavy weaves.

An improved winder of simplified design has recently been developed for rayon and silk. It embodies a new method of driving the spindles, and eliminates the individual clutch and complementary parts for every spindle. The drying machine is unique, yet simple.

A new twister equipped with a single vertical high-speed motor drive and a simplified twist-gear construction has been developed for the silk industry.

One of the recent developments in handling rayon is a new machine designed to facilitate the sizing of ribbon warps. It is rather a combination of warper, beamer, and slasher, but is apparently designed to fill a place much needed in the rayon industry.

Knitting

Probably the outstanding development in the knitting industry is the introduction of a number of single-unit full-fashioned hosiery machines. These machines are now being demonstrated in one of the plants in this country, and the inventors contend that it will prove very valuable to the industry by eliminating many of the difficulties now encounted in machines of this type.

There has been developed for the hosiery industry a warp-strips circular hosiery machine which permits an increased number of steps and an equal number of colors. It employs three perpendicular color changes and is built on a spiral frame, thus affording the attendant spiral designing possibilities.

A fancy reverse-plated circular hosiery machine has been developed in England. This machine permits continuous production of the several types of hosiery of plain and fancy design.

The Wood Industries[1]

THE year 1931 has seen a concerted attempt of the lumber industry through the U. S. Timber Conservation Board to develop a broad economic program for stabilizing the industry. A preliminary report submitted by the special Lumber Survey Committee, on current lumber production, stocks, consumption, and prospective consumption, made certain recommendations as to curtailment of production and for the stimulation of consumption.

Similar attempts to improve economic conditions in the industry have been and are being made by various trade associations, and the movement for acceptable standards, trade-practice rules, simplified practice, and research have received renewed impetus in the past year.

The Bureau of Standards has announced that the commercial standards for grading plywood recommended to producers received wide acceptance and were made effective for new production on September 1.

Representatives of woodworking and lumber industries met in Chicago in October under the auspices of the National Safety Council to consider practical ways and means under a cooperative program for the reduction of accidents and accident costs. Reports for 1931 showed a 17 per cent reduction in accident frequency rates of ninety-nine establishments listed by the Council over a three-year period, contrasted with a reduction of 28 per cent by the entire group of 28 other industries whose accident experience is tabulated. The lowest accident frequency rate was in the furniture-manufacturing group.

A Government contract has been awarded for the construction at Madison, Wis., of a new fireproof building to house the Forest Products Laboratory of the U. S. Forest Service. Equipped with the most modern technical and scientific facilities, the laboratory will be enabled to continue and broaden its service to the wood industries.

The first southern and sixth national meeting for executives and engineers and technologists in the wood industries was held

[1] The executive committee of the A.S.M.E. Wood Industries Division, whose annual progress report is here presented, consists of Thomas D. Perry, *Chairman*, Chester L. Babcock, *Secretary*, Armen S. Kurkjian, Ralph K. Merrill, and Arthur D. Smith, Jr. The original report was prepared by Paul H. Bilhuber.

by the Wood Industries Division of the Society at Winston-Salem, N. C. The splendid representative attendance signified the increasing interest in and the importance of this Professional Division activity in stimulating further engineering progress in the woodworking field.

Consumption of Wood

Worthy of note is the increased consumption of fiber, pulp, and paper products contrasted with a marked decrease in the per capita consumption of lumber. A decided trend toward the utilization of wood waste, little-used species of lumber, and wood flour as a filler for plastic materials is notable, as is also the commercial development of pulp and paper mills on the West Coast.

Processing Wood

There is also a marked tendency to perfect and develop new chemicals and processes for wood preservation, fire retarding, and other technical processings of wood. A prominent automobile manufacturer has recently announced a process of treatment for wooden body parts to guard against tropical rot and weather, claiming a measure of insulation against vibration noises, heat, and cold. Mill priming of lumber such as house siding, trim, etc. has been developed as a partially protective coating for surfaces ordinarily left unpainted or as a priming coat for subsequent top coats, and if wisely merchandised will represent a step in advance in the lumber industry.

Fire-retardant wood is finding an increasingly large market in building construction in congested districts, and in partition and trim for passenger steamships, among other uses.

Manufacturing and Machinery

A number of important auto-body manufacturers have recently converted their plants in congested centers into assembly units, transferring their dimensioning and milling operations to plants nearer the source of supply. Thus the dimension idea is steadily gaining ground because of its economic advantages.

During the year the more active wood fabricators have been the furniture and panel plants of the Southeastern section.

Woodworking machines of multiple-operation types have found more ready acceptance by the industry in the more intensive search for reduced costs and improved quality. Manufacturers with research facilities have used them in the development of new products or new lines to utilize plant capacity. The new cutting steels have found a wider application in the woodworking industry due to the increased use of treated wood.

The loss of markets to competitive materials still continues. A realization of the importance of the moisture-content factor in obtaining proper utilization of wood is, however, increasingly evident. New and improved dry-kiln design and practice, more widespread use of moisture-content indicating apparatus, and the use of publicity to present properly the advantages of wood are helping to curtail this loss.

Faraday's Steels and Alloys

HITHERTO, the only information available concerning Faraday's metallurgical researches has been that contained in papers which he presented jointly with James Stodart, F.R.S., to the Royal Institution in 1820, and the Royal Society in 1822, but not much definite information from the modern point of view is to be gleaned from those papers, as they contain very little in the way of chemical analysis or quantitative tests. By permission of the managers of the Royal Institution, Sir Robert Hadfield has been able to investigate the nature and properties of seventy-nine specimens of Faraday's steel and alloys by the aid of the resources of a modern research laboratory. From the information thus obtained, which could have been secured by no other means, it is evident that Faraday's work constituted an important and valuable research, specially considering the state of metallurgical knowledge and practice at the time. In fact, it was not only his first research, but also the first systematic research in the field of steel alloys on a comprehensive scale.

Faraday made and examined alloys of steel with at least sixteen different elements as well as four special compounds, and though the specimens examined by Sir Robert represent only a portion of the total number made by Faraday, it is clear that his work by no means ended in failure, as has been stated by some who were not metallurgists and were only able to inspect the specimens, if, indeed, they saw them at all. Some of the most interesting alloys made by Faraday, including those containing very high percentages of platinum and rhodium, were not to be found in the small deal box, labeled "Steel and Alloys," in his own handwriting, which lay in the storeroom of the Royal Institution for more than a century.

All that has survived is the deal box, containing seventy-nine specimens, of which only thirteen weighed 100 grams ($3^1/_2$ oz.), or over, the heaviest 140.10 grams (5 oz.), and the other sixty-six averaged only 31 grams (1.1 oz.) each. The total weight of the seventy-nine specimens was 7 lb. 14 oz. Information given in Stodart and Faraday's papers of 1820 provides some useful clues of a general nature, but there is nothing to indicate the actual composition of the individual specimens. Nevertheless, with so small a total weight of material, with so many alloys of different and quite unknown composition, and with the further handicap of having to work with a small portion of each specimen, so that none of these valuable relics might be completely destroyed, Sir Robert has succeeded in determining the composition, nature, and properties of the greater portion of them, and from them he has discovered much information useful today.

Sir Robert Hadfield not only describes his own research on Faraday's specimens and presents the results obtained, but he also relates the circumstances which led up to Faraday's research, and describes the methods employed by that great experimental philosopher in that, the first, of his important researches. The great influence of wootz, or Indian, steel in the early years of the last century is explained and the relation between James Stodart, the maker of surgical instruments and cutlery, and Michael Faraday, who at that time regarded himself primarily as a chemist is made clear. The primitive state of scientific and metallurgical knowledge in those days is indicated, and the hand-blown "blast-furnace" and crucibles in which Faraday prepared his alloys are described. With these resources Faraday was able to melt pure iron, and to make alloys of platinum and steel. He could, in fact, reach such temperatures as often caused his best crucibles to soften and break down. Sir Robert relates how the long series of small-scale experiments conducted by Faraday himself in the Royal Institution were followed by the manufacture of alloys on a comparatively large scale at Sheffield.

Faraday is and will always remain, most famous for his electrical and chemical researches, but the facts disclosed, it is believed, for the first time by the present research, entitle him to be regarded as a metallurgical investigator of the highest ability and the pioneer of alloy steels.—From report of the British Association Centenary Meeting, in *The Engineer*, Sept. 25, 1931.

Survey of Engineering Progress

A Review of Attainment in Mechanical Engineering and Related Fields

APPLIED MECHANICS

Twisting Stress in High-Pressure Piping

THE author compares the Birnie, Clavarino, and Barlow formulas as applied to piping and comes to the conclusion that where closed-end conditions are prevalent Clavarino's formula is theoretically correct and in the author's opinion should be used where exact results are desired. If, for any reason, it is desired to allow a greater factor of safety, this should be done by designing for a lower working stress in Clavarino's formula. Birnie's formula, while inexact, errs on the side of safety. The author next shows the fundamental theoretical differences between the Birnie and Clavarino formulas, as well as their difference in application.

If the ends of the pipe are attached solidly to the pipe walls, a stress is also produced in an axial direction which tends to shorten the radial dimension and also the tangential dimension of the particle: Any actual pipe line approaches this state, which should be considered the limiting condition in design. Lamé's equations consider each stress as acting independently. The limit of elastic resistance, however, must be reached through a combination of these stresses. Theories regarding their combination do not agree, so that it is necessary to rely upon test results to indicate the correct theory.

The author considers next the three principal theories (Rankine, St. Venant, and Guest) as to when elastic failure is produced, and comes to the conclusion that for ductile materials the Rankine theory is not suitable, while the St. Venant formula seems to be better founded.

He next considers the case of a closed cylinder with ends attached to the pipe walls. In this case the stress as computed by Birnie's formula will be greater than that computed by Clavarino's, other things being equal.

He points out, however, that the use of Barlow's formula is often justified from the standpoint of ease of solution. In piping work the condition most often encountered is that of a pipe with closed ends, which may result in a pipe line from closing a valve. For this condition the formula of Clavarino is theoretically correct, and tests have shown that for conditions where Clavarino's formula applies, test results agree very closely with computed values. As shown in Fig. 1, for t/D ratios up to approximately 0.15, any one of the formulas mentioned may be used satisfactorily.

It is of interest to note from Fig. 1 that it is impossible to design a simple cylinder to withstand a fluid pressure beyond a certain value for a given material. This may also be seen from the following equation:

$$\frac{P}{S} = \frac{D^2 - d^2}{1.3D^2 + 0.4d^2}$$

To obtain the maximum allowable value of P/S, assume d = 0, or the condition of an infinitely thick cylinder (solid). For this condition, the value of P/S = 1/1.3 or 0.769. The practical limit is reached at a lower value of P/S, inasmuch as the constant 0.769 represents the condition of a solid cylinder and is of no practical importance with respect to piping problems.

The author agrees with Mr. Harman's conclusions that for ordinary purposes and for ranges of t/D up to 0.3, the Barlow formula gives results well within the scope of error justified by the use of commercial pipe and tubing where variations in strength of material, wall thickness, temperature stresses, etc., are too great to warrant the use of theoretically correct formulas such as those of Clavarino or Birnie. Where theoretically correct results are desired, however, Clavarino's formula, in the author's opinion,

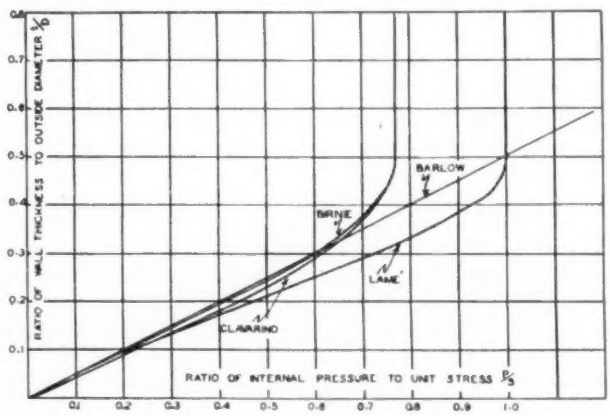

FIG. 1 COMPARISON OF INTERNAL-FLUID-PRESSURE FORMULAS

should be used for piping work if closed-end conditions prevail. (Harvey D. Wagner, Engr., Detroit Edison Co., Detroit, Mich. in *Heating, Piping, and Air Conditioning*, vol. 3, no. 8, Aug., 1931, pp. 658–661, 4 figs., *ep*. This article is partly a comment upon an article entitled, "Higher Pressures and Temperatures as They Affect the Design Installation and Maintainence of Piping," by J. J. Harman, Dec., 1930, *Heating, Piping, and Air Conditioning*, p. 985, and is accompanied by a comment by J. J. Harman, pp. 661–663, 1 fig.)

AUTOMOTIVE ENGINEERING (See Internal-Combustion Engineering: Heavy-Oil Engines for Motor Vehicles)

ENGINEERING MATERIALS

An Alloy Steel for Use as Rolled

ONE OF the great disadvantages attending the widespread use of alloy steels has been the necessity of heat treating these materials in order to develop their potential worth. Such practice frequently calls for expansive heat-treating and pickling operations, and extreme care must be maintained to insure keeping the steel in this heat-treated condition so that its valuable properties will not be impaired.

This problem has been greatly simplified by the recent develop-

ments of a series of low-alloy steels containing chromium, manganese, and silicon. These new alloy steels have been introduced under the name of "cromansil" steels, a general term used to designate not one special steel but all steels whose composition comes within the recommended range of alloy content. The properties and applications of these steels are described in detail in a 12-page technical bulletin issued by the Electro Metallurgical Company, entitled, "Cromansil Steels."

The most useful forms of cromansil steel contain from 0.4 to 0.6 per cent chromium, 1.1 to 1.4 per cent manganese, and 0.7 and 0.8 per cent silicon, with a carbon content ranging from less than 0.10 to 0.65 per cent, depending upon the particular use to which the steel is to be put. The presence of these three elements in combination results in high ultimate strength, great ductility, high fatigue limit, high impact strength, and ready machinability. Another important effect is the increase in latitude of allowable finishing temperature of rolling. This property alone is of great aid in producing what is practically a "foolproof" steel.

Easily manufactured by the open-hearth process, these steels can be used as rolled, or in the heat-treated condition. By selection of appropriate alloy percentages it is generally possible to obtain the desired physical properties without any heat treatment or with a simple normalizing, with or without subsequent tempering. Greater strength and ductility than in any other form of plain carbon steel can be obtained in the "as-rolled" condition of cromansil steels.

Cromansil steels can be made by any skilled steel maker without additional experience or training, and can be produced in the open hearth at a slight increase in cost. They can easily be rolled into billets, plates, bars, and any shapes ordinarily fabricated from carbon steel. Forging and piercing and drawing into seamless tubing can also be accomplished according to the usual practice. All fabrication operations such as punching and drifting can be carried out with comparatively little additional trouble or expense.

Welding is performed according to the usual procedure control for ordinary carbon steel of the same shape. Except for plates over one inch in thickness or steels having a high carbon content, no subsequent heat treatment is necessary. Normalizing is all that is required in any case to bring the strength of the weld up to that of the base metal.

A few of the applications in which this type of steel is especially advantageous are ship plates and naval structural parts, bridges, and buildings where a high strength-weight ratio is valuable, chimneys, penstocks, pressure vessels, tanks, boilers, staybolts, and high-strength seamless tubing, such as oil-well casings. The improved physical properties of cromansil steels meet the requirements of such applications and at the same time remove to a great extent the need for heat treatment to develop desirable characteristics. (Mimeographed press release of the *Electro Metallurgical Company*, New York City, *d*)

FOUNDRY

The Speed of Rotation in the Centrifugal-Casting Processes

THE author considers casting about a vertical axis and about a horizontal axis. For the former he gives formulas both in terms of angular velocity and in revolutions per minute. As regards rotation about a horizontal axis, he discusses both general mechanics and the action of molten metal poured on to the surface of a rotating mold, i.e., the internal friction beyond the liquid layers of metal as the effect of increase in velocity during solidification. The relation between the tangential force on the metal and the viscosity he expresses by the equation $R = Va\beta/S$, where R is the tangential force, V the velocity of the moving layer, a the area of surface affected, and β the coefficient of viscosity.

In the case of alloy materials the viscosity of the liquid metal during solidification increases rapidly and this effect is probably of importance in determining the rapid acceleration of molten metals in commercial centrifugal-casting processes.

With certain exceptions, in commercial centrifugal-casting processes the molten metal is applied to the rotating mold with a certain initial velocity. If the initial velocity of the molten stream applied to the mold is the same in magnitude and direction as that of the mold at the point of application, then the time required for the acceleration of the molten metal due to the rotation of the mold is nil. The values of the initial and final metal velocities can be determined in particular cases by an examination of the pouring position. This is illustrated in the original article by diagrams.

The author gives a minimum speed condition of 1200 ft. per min. peripheral velocity. This speed has been determined by experiment in the production of castings of from 4 to 12 in. in diameter, and on short lengths operating with hot cast-iron molds having an internal surface temperature of approximately 550 to 600 deg cent. and rotating about a horizontal axis. Below this speed, irregularity of dimensions was constantly encountered in the castings. Under somewhat similar mold conditions but operating with molds 36 in. in diam. and 12 ft. in length and pouring with a helical-edged pourer, the molten cast iron was constantly and uniformly accelerated at a speed of 166 r.p.m., corresponding to a peripheral velocity of 1500 ft. per min.

The author gives a collected list of rotational speeds which have been published from time to time by various authorities in relation to several of the different processes. In the DeLavaud process the rotational speeds are subject to certain special considerations. Dr. Pardun's investigations on a machine producing castings of 12 in. internal diameter, $^1/_2$ in. radial thickness, and 17 ft. length show a minimum speed of 400 r.p.m. or 1260 ft. per min. Cammen determines the speed relationship by a consideration of uniform centrifugal pressure from the formula $1675/\sqrt{R}$, where R is the radius in inches. Moldenke gives $1550/\sqrt{R}$, R being the inside radius in inches for values of R from 2 to 36 in. The values of peripheral velocity for various values of R in the Cammen and Moldenke formulas are given in a table in the original article. (J. E. Hurst in *Foundry Trade Journal*, vol. 45, no. 785, Sept. 3, 1931, pp. 145–147, 5 figs., *pc*)

INTERNAL-COMBUSTION ENGINEERING

The Fowler Oil Engine

THIS is an ignition-compression engine, and the novelty lies in the design of the piston, in the head of which a cavity is formed. This cavity communicates with the combustion space by means of a narrow passage, and its purpose is to diminish the rate of combustion of the charge, thus eliminating detonation.

The theory back of this development is that one of the most important factors influencing the performance of compression-ignition engines is the rate of pressure rise immediately after ignition. If that is too rapid, detonation ensues.

In the course of experiments it was found that by providing an extra air chamber in the piston head and connecting it by a narrow passage to the combustion chamber, it was possible to cut down the detonation without affecting efficiency or the ease of starting.

The operation of this chamber is as follows: When the air is initially compressed in the cylinder a portion of it is trapped in

this cavity, with the result that when the charge of fuel is first injected it burns only in conjunction with that portion of the air supply that is above the piston head, and therefore with a shortage of air. This has the effect of retarding combustion. As soon as the piston starts on its downward stroke the air in the piston cavity begins to be released and combustion is continued. The result is smoother running, reduction of load on the bearings, higher maximum speeds, and a clean exhaust, with absence of knock.

The engines will burn all standard fuel oils up to 0.88 specific gravity, and, if arrangements be made for starting on a lighter oil, fuels up to 0.94 specific gravity can be used. (*The Commercial Motor*, vol. 54, no. 1383, Sept. 15, 1931, p. 139, illustrated, *d*)

An Australasian Rotary-Valve Engine

THE design of this engine originated in New Zealand, but a single-cylinder engine incorporating the new valve was shown to the author of the original article in England.

In this engine the valve is situated horizontally above the cylinder head with its axis at right angles to that of the crankshaft. The cylinder head is connected by two long rectangular ports with the valve cylinder in which a long piston valve both rotates and reciprocates.

This combined movement of the valve and the manner in which it is obtained are the chief features of the design. Driven from the crankshaft by any suitable means is another small crankshaft which operates the valve. Encircling the crankpin of this shaft and fixed to it there is a bevel wheel, with which meshes a bevel wheel having a bearing on what is really a very

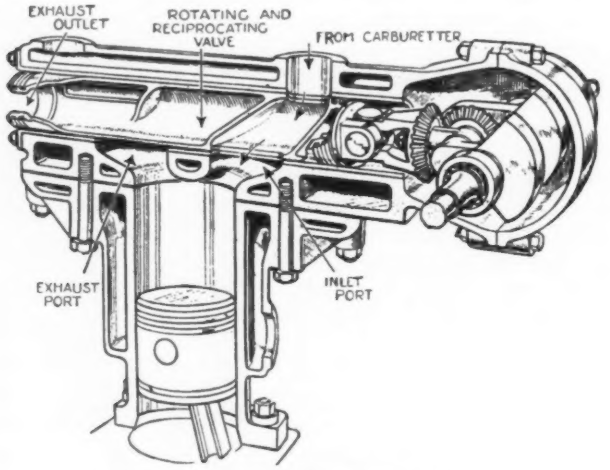

FIG. 2 DUPLEX ROTARY ENGINE VALVE

short connecting rod. Formed on this bevel wheel is a fork which forms part of a universal joint, the other fork of the joint being pivoted to the end of the valve piston.

Thus, as the crankshaft rotates, the valve is moved backward and forward along the cylinder, and at the same time is rotated by the action of the bevel wheels. Ports are formed in the valve piston, and also in the valve cylinder, for the admission of gas and for the exit of the spent gases. In the present arrangement the inlet port from the carburetor is above the cylinder, while the exhaust port is formed at the end of the cylinder, the exhaust pipe being connected there.

Lubrication of the valve is by splash from the driving mechanism. It is claimed that the rapid motion of the valve in closing results in a portion of the mixture, at that instant in the actual port passage in the valve itself, being thrown into the combustion space, so giving a degree of supercharging.

A general description of the operation of the engine is given in the original article.

The illustration, Fig. 2, shows the construction of the valve and the method of operating it by a crankshaft and connecting rod embodying bevel wheels and a universal joint. (*The Autocar*, vol. 67, no. 1872, Sept. 18, 1931, pp. 485–486, 2 figs., *d*)

Heavy-Oil Engines for Motor Vehicles

AFTER a brief discussion of heavy-oil engines generally, the author proceeds to brief descriptions of the following motors: Saurer, Deutz, Maybach, Morton, and Rupa. He also describes the Bellem attachment for converting a gasoline motor into a heavy-oil motor, and also the principles of the Rochefort motor and the Chilowski gasifier. The Bellem device is a single-cylinder pump feeding the distributer and atomizers, of which there is one for each cylinder. The camshaft is shaped in such a manner as to produce a lag of 120 deg. in the opening of the admission valves. The heavy oil then injected is volatilized because of the vacuum thus produced. The pump runs at a speed twice that of the motor. Its output can be modified and is regulated by the accelerator, which also regulates the quantity of air admitted to the cylinders. Moreover, means are provided to vary the respective proportions of air and combustible. It is claimed that the motor is started from cold on kerosene. The original article gives an elaborate chart obtained experimentally by the Director of the Machinery Experiment Station of the French Ministry of Agriculture. These tests appear to have been quite successful.

In the Chilowski device the intention was to obviate the difficulties due to the reactions produced in combustion. It is stated that combustion dislocates profoundly the first molecules that it attacks, but that the greater part of the heavy oil is subjected to insufficient heat action. To avoid this difficulty the inventor, in addition to as complete atomization of the oil as possible, employs a certain amount of air previously heated to a temperature in excess of that of spontaneous ignition of the oil (between 500 and 700 deg. cent.). The combustion chamber is so arranged that its walls are kept at a temperature of 1100 deg. cent.

Under these conditions the following reactions may develop. First, combustion of a small part of the oil vapor developed by contact with the hot air. This condition produces just enough energy for an intense oxidation of the globules of the oil. Second, the destruction of the liquid phase by the explosion of oxidized globules which unquestionably accompany the conversion of the heavy-oil molecules into lighter molecules. Third, oxidation of the lighter molecules, which may require a lapse of time of the order of $^5/_{100}$ sec., this oxidation not being, however, a combustion in the strict meaning of the term as it occurs without flame and without the creation of particles of carbon.

It would appear, therefore, that the Chilowski process has for its purpose the complete gasification of heavy oils by partial oxidation at high temperature, transforming oil into gas which is not condensable at room temperature.

The oil is injected into a chamber with incandescent walls by means of air used for the partial oxidation of the oil. This air, supplied under pressure by a compressor, is introduced, together with the oil, into the chamber by a special atomizer, which breaks up the oil very finely and mixes the two fluids. Under the action of the temperature prevailing in this chamber (950 to 1050 deg. cent.), or (1742 to 1922 deg. fahr.) when the operation is normal, an extremely rapid oxidation of the fuel takes place, and this oxidation provides the necessary heat energy, a part of which is used for cracking the oil and for maintaining the combustion chamber at its normal temperature.

The heat energy required for the gasification of the oil is supplied in part by the preliminary reheating of the air used for the

partial oxidation. This reheating, which occurs at a temperature at least equal to the temperature of spontaneous ignition of the oil, together with the calorific economy which it provides, is indispensable for producing the phenomena of oxidation and gasification, and stabilizes the beginning of these phenomena from the time of the entry of the mixture of oil and air into the combustion chamber. The reheating of the air is obtained by recuperation from the incandescent gases leaving the combustion chamber. The apparatus therefore consists of a gasification chamber, an atomizer, and an air reheater, all of these being enclosed in an insulating jacket. The output of the compressor is automatically proportioned to the output per cylinder volume of the motor. The mass of the air is divided into two parts. One, a small amount, passes through the fuel-proportioning needle, while the other part is used for the atomization of the entrained fuel.

Tests with this device were made on a five-ton truck. It is claimed to have given satisfactory results. (Edmond Marcotte in *La Revue Industrielle*, vol. 61, no. 2266, pp. 518–524, 5 figs., *d*. For the Bellem engine, see *Journal*, A.S.M.E., vol. 37, May, 1915, p. 287)

The Bertin Gas Turbine

THE principle of this turbine, invented and built by G. Bertin, is shown diagrammatically in Fig. 3. A flat disk containing a large, circular, centrally located hole has cut on one of its faces a channel A in the form of a logarithmic spiral making at every point a constant angle of 45 deg. with a corresponding radius. The cross-section of this channel uniformly increases from the periphery to the center.

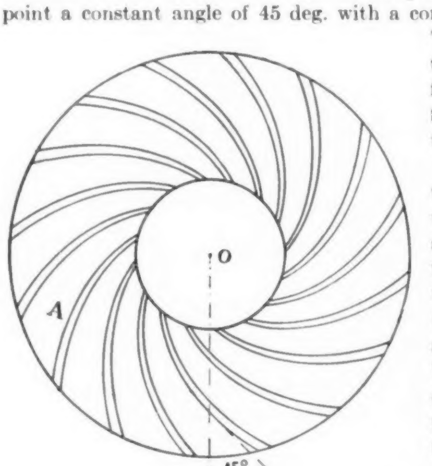

FIG. 3 DISK WITH SPIRAL CHANNELS AS USED IN THE BERTIN TURBINE

Let it be assumed that face to face with this disk is a second disk of identical shape. This will result in the relative positions shown in Fig. 4. The median lines of the channels of the two disks will then intersect at 90 deg. If the disk containing the spiral channel AA' turns in the direction of the arrow f, Fig. 4, while the other disk remains stationary, it will be found that curvilinear quadrilaterals such as *abcd*, formed by the sides of the two intersecting channels, are gradually displaced from the periphery to the center. It will be noticed that at the same time the depth and cross-section of each of the channels also increase from the periphery to the center, in such a manner that the cellular volume (not entirely closed) corresponding to this curvilinear quadrilateral *abcd* also increases. The result of this is that should the orifices on the periphery be placed in communication with a vessel containing a gas under pressure, this gas will flow into the spiral channels and expand with the growth of the cellular volume. If the increase of the cellular volume is the same as the increase of the volume due to the decrease of pressure, the expansion will take place without increase of kinetic energy.

An objection may be raised to the effect that the device is likely to produce losses due to friction between the streams of gas circulating in the rotating disk and those flowing in the stationery disk. Actually, however, as soon as a suitable velocity of flow is attained the absolute velocity of the fluid which circulates in the rotor (the rotating disk) is the same as the velocity of the fluid moving through the stator, and hence all loss due to shock between the flowing streams of gas is eliminated. As a matter of fact, if W_S (Fig. 6) is the absolute velocity in the channel of the stator, W_R is the homologous velocity of the fluid circulating in the rotor and W'_R is the relative velocity of the same fluid with respect to the rotor. Then, as shown in the velocity diagram of Fig. 6, the relative velocities W_S and W_R (in the original article through misprint W is used) form a right angle as the median lines of the channels of the two disks from two sides of the spirals. Moreover, they form an angle of 45 deg. with the entrainment velocity u due to the rotation of the rotor. The absolute velocity W_R' is the geometric resultant of W_R and u. Its geometric difference from the vector W_S is represented by the vector W_{RS}. At starting or stopping, u is equal to zero or is very small. W'_R coincides with W_R and W_{RS} is very large, but as the speed of the machine increases, the difference W_{RS} decreases, and it is always possible to select such an operating velocity that u should be equal to $\frac{W_S + W_R}{\sqrt{2}}$ and hence W_R should coincide with W_S. The absolute velocity of the fluid streams in the rotor will then be the same as the absolute velocity of the fluid streams in the stator at each point of intersection.

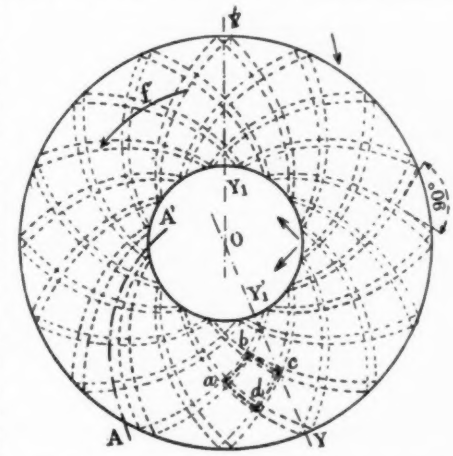

FIG. 4 DIAGRAMMATIC ILLUSTRATION OF THE SUPERPOSITION FACE TO FACE OF TWO DISKS OF THE KIND SHOWN IN FIG. 3

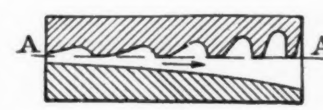

FIG. 5 DEVELOPMENT OF A SECTION ALONG LINE AA' IN FIG. 4

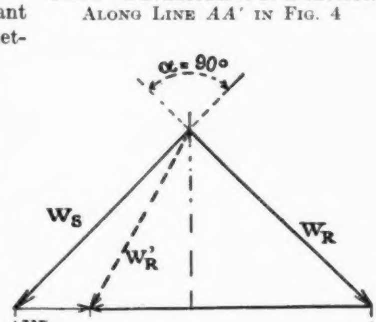

FIG. 6 DIAGRAM OF VELOCITIES

In an actual machine there is an advantage in arranging the device axially rather than radially in order to facilitate the entrance and exit of the fluid medium employed. To achieve this, all that is necessary is to consider a part of the system comprised between the radii YY_1 and $Y'Y'_1$ (Fig. 4) as the lateral developed surface of a truncated cone, and to roll it around an axis of revolution in such a manner that YY_1 will be made to coincide with $Y'Y'_1$.

In the case of a turbo-compressor it is necessary to preserve the arrangement of flat disks with the channels cut in their faces as described above, so as to make use of the action of centrifugal

force along the spiroidal channels. The disks in each pair can then be given opposite velocities.

It is claimed that the Bertin machine may be employed as a gas turbine. In such an event the channels can be made in a refractory material capable of withstanding the high temperatures used in gas turbines. Illustrations in the original article are said to show a gas turbine built by the inventor and running at a speed of 5250 r.p.m. The inventor expects that when this machine is equipped with a turbo-compressor built according to his design, it will develop from 20 to 30 hp. (J. L. in *Le Génie Civil*, vol. 99, no. 5, Aug. 1, 1931, pp. 117–118, 6 figs., *d*)

IRON AND STEEL

A Three-High Blooming Mill With Mechanical Reversing

THE place occupied by the blooming mill in the majority of European steel plants is different from that which it does in many American plants. The fully continuous mill is only very rarely met with in Europe, because of the highly diversified nature of the working program of European mills and the fact that as only relatively small quantities of the individual products are ordered, the mills must be able to change over rapidly from one type to another.

On the other hand, the use of semi-continuous mills with a continuously working blooming mill in front of the finishing stands has been growing. The only trouble with this arrangement where the conventional type of blooming mill is used is that the output capacity of the continuously working blooming mill is two or three times the amount that the finishing mill can handle, while the initial cost of a blooming mill of this type is disproportionately high in relation to the output that would be required of it.

The mill here described, developed by the Krupp-Gruson Works, is intended to solve the problem by the employment of certain special auxiliary devices.

The square ingots coming from the furnace are fed in between the top roll and middle roll by a set of narrow live rollers and are rolled down into rectangular sections. On leaving the rolls the rectangular bloom passes on to the angular guide bar of a tilter, the guide bar being so constructed that the bar being rolled continues to travel along it until it leaves the rolls. It is then carried along oblique slides to the front of the next pass, being tilted at an angle of 90 deg. while slipping down. The guide bars behind the individual passes vary in length in accordance with the extension in length of the bar being rolled. The latter drops on to a set of rollers in the rear of the first stand, running steadily toward the rolls.

These rollers carry the piece edgewise into the next pass, where it is again pressed square. In front of the rolls the piece is received on a tilting table, which by means of its live rollers carries the bar into the next pass, immediately above the previous one. Behind the stand, where the tilter is also placed, a closing arrangement is built in, which, being positively connected with the tilting table in front of the rolls, prevents the introduction of a piece between the rolls when the tilting table is in the raised position.

The process taking place in the rear of the first stand is then repeated twice, so that the bloom, which is given six passes on the first roughing stand, is turned on edge three times and after the sixth pass travels, as a square billet, over the tilting table to a set of discharging rollers. A set of live rollers, ending in front of this stand in a sloping channel with loose rollers, feed the billet in between the top roll and middle roll of the second stand, in which it is given three additional passes. As the piece is already reduced in cross-section, a mechanical reversing gear is provided on this stand for the purpose of taking the piece from one pass to the other. After the last pass the piece travels through a channel formed of angle bars to the first stand of the finishing mill. (E. Kaestel, Ch. Engr., Magdeburg, in *The Iron and Coal Trades Review*, vol. 123, No. 3314, Sept. 4, 1931, p. 327, 3 figs., *d*)

MACHINE PARTS

A High-Angle Universal Joint

IT IS CLAIMED that this joint, made by the Weiss Engineering Co., possesses the characteristic of transmitting motion uniformly regardless of the angle between the connected shafts. This joint depends upon maintaining the plane of driving engagement between the two couplings at half the shaft angle. This is accomplished (see Fig. 7) by placing a number of steel balls in intersecting races in the two joint members. The longitudinal axes of the grooves are struck from different centers with varying

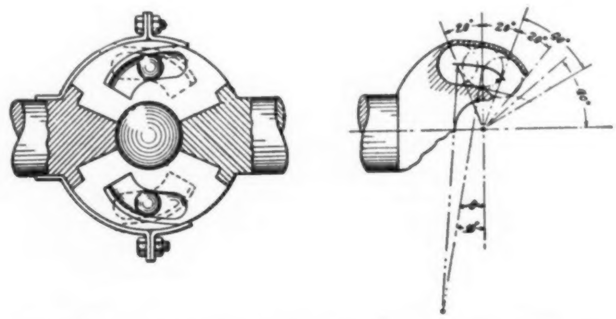

FIG. 7 WEISS UNIVERSAL JOINTS WITH BALL CURVES OF VARIABLE RADII

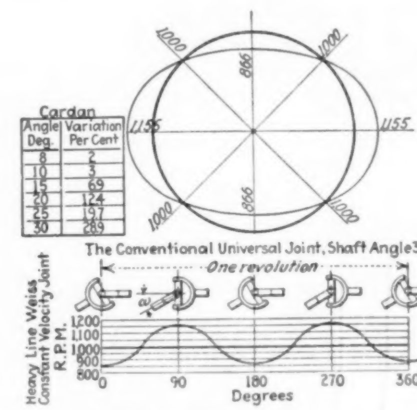

FIG. 8 SPACE-VELOCITY DIAGRAM OF THE WEISS UNIVERSAL JOINT AS COMPARED WITH THE CARDAN JOINT

radii, so that the large angle of the grooves necessary for operation at large angularity of the joint members is obtained without being accompanied by rapid wear on the balls and curves when the joint is being worked at small angularity.

To illustrate further the effect of these velocity changes, there is shown a space-velocity diagram of the Cardan joint as against the Weiss universal joint. (Fig. 8.) For a propeller-shaft angle ω of 30 deg. the per cent fluctuation in angular velocity is 28.9 per cent, and at 40 deg., 54 per cent. At 15 deg., the angular fluctuation is only 6.9 per cent, so it will be seen that the fluctuation increases rapidly with the propeller-shaft angle. (*Automotive Industries*, vol. 65, no. 12, Sept. 19, 1931, p. 438, 2 figs., *d*. Compare article in *Product Engineering*, Oct., 1930, p. 490 and 491, 4 figs.)

The Flexia Universal Joint

AN ATTEMPT has been made to substitute for the plain metal universal joint one with rubber disks in order to eliminate vibration and shocks. This does not seem to have been successful, and the present design is intended to create a type returning to the metal universal joint, but free of some of its alleged defects. In the Flexia universal joint each end of the shafts

Fig. 9 Rope Element and Rope Nipples of the Flexia Universal Joints

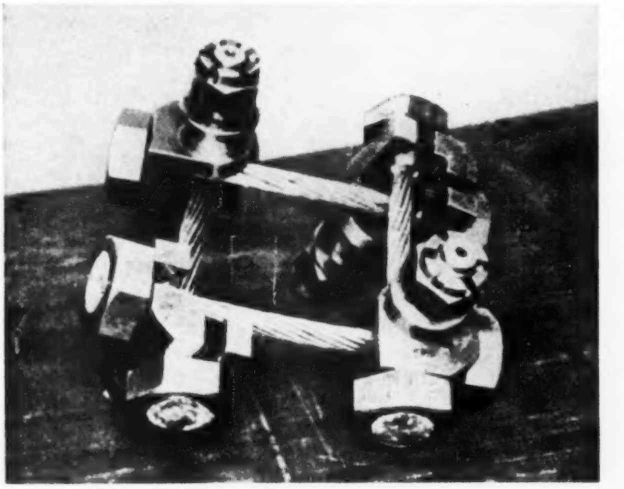

Fig. 10 The Flexia Universal Joint

is equipped with two armed flanges carrying nipples intended to hold the ends of the wire-rope elements (Fig. 9). There are four such wire-rope elements arranged in a square in such a manner that the corners lie in the middle line between the holding bolts for the rope nipples. If such a joint (compare Fig. 10) is set on the shafts, the tensile force will fall in the middle lines of the ropes set in straight lines. The lines connecting the holding bolts of the rope nipples form the intersection of the axes of the universal joint. There is, therefore, here as in the strictly metallic universal joint a pure Cardan action, but because of the use of flexible ropes the device, unlike the universal metal joint, has a considerable amount of elasticity which permits it to transmit power without shock. Even when the angle between the shafts is large the ropes remain practically at rest as they move only to a very small extent to one side or the other. The ropes are, of course, subject to fatigue and stretching. All that is necessary to take care of this is to loosen the nuts with which the rope element is held against the holding nipples and rearrange the unit. (Civil Engr. Lesser in *Deutsche Motor-Zeitschrift*, vol. 8, Feb. 26, 1931, pp. 90 and 92, *d*)

MACHINE-SHOP PRACTICE

Making Expansion Fits With Liquid Air

THE EXPANSION fit is new in the mechanical field. This term describes the method of assembling a pin, shaft, or bushing in a hole of slightly smaller diameter by cooling the inner member with liquid air so that it will contract sufficiently to enter the hole. While this process is not recommended where ordinary shrinkage fits can be made, there are numerous cases in which expansion fits can be made more advantageously and economically. There are also cases in which heat cannot be employed.

Expansion fits are good practice when the outer member is very large and heavy as compared with the inner member, or when the heating of the parts might cause cracking or warping. Liquid-air expansion fits can also be made where heat would injure rubber parts, insulation, or other materials attached to one of the members, or where a suitable furnace is not available for heating the work.

Liquid air with an analysis varying from 40 per cent liquid oxygen and 60 per cent liquid nitrogen to 60 per cent liquid oxygen and 40 per cent liquid nitrogen is suitable for making expansion fits. The boiling temperature of such a liquid is somewhere between that of liquid oxygen and liquid nitrogen, depending on its composition, and for estimating expansion-fit allowances, may be taken as —190 deg. cent., which is equivalent to —310 deg. fahr.

For expansion-fit practice it may be assumed that 200 B.t.u. are required to evaporate one liter of liquid air. Thus liquid air has a capacity for withdrawing 200 B.t.u. from parts immersed in it per liter (1.057 qt.) of liquid evaporated.

A metal part at 70 deg. fahr. is relatively very hot compared with liquid air at the boiling temperature of —310 deg. fahr. When a part is immersed, the liquid air boils violently and continues to boil until the part has been cooled to the temperature of the liquid. This may require several minutes with heavy parts. The quantity of heat withdrawn from the submerged part is equal to that absorbed by the liquid air, which, in turn, indicates the amount of liquid air evaporated by the part.

As each 200 B.t.u. given off by the part will evaporate one liter of liquid air, the shape of the part has no effect on the amount of liquid required; however, the shape does affect the time element, a flat piece with a large surface area requiring much less time to cool than a spherical part of the same weight but of smaller surface area. When only a portion of a part is submerged, as the end of a shaft, for example, an allowance must be made for heat conduction, the amount of liquid evaporated being greater than if the portion submerged were a separate piece. The amount of additional liquid required can best be determined by trial.

The original article gives a table containing data for determining the approximate amount of liquid air to be evaporated in cooling various metals. Another table gives the approximate contraction per inch of length or diameter for different metals when cooled from +70 deg. fahr. to —310 deg. fahr. in liquid air. Allowances for expansion fits are based on these values. If the allowance is too great the elastic limit of the material in one or both parts will be exceeded and a permanent set will occur. In extreme cases a rupture may be caused. Recommend sliding-fit allowances are given in another table in the original article. Where the diameters are too small for satisfactory expansion fits, or when an unusually powerful grip is specified, the fit may be made by cooling the inner part in liquid air and heating the outer part. In such cases the outer part is usually heated in boiling water (212 deg. fahr.). The outer part is thus expanded and the inner part contracted so that they can be assembled.

The approximate linear expansion per inch of length of diameter for parts of different metals, on being heated from 70 to 212 deg. fahr., is given in a table in the original article. For a combination fit, the inner part should be machined at room temperatures to the same diameter as for an expansion fit, except that an allowance should be made for the expansion of the hole in the outer part.

Examples illustrating the application of liquid air to expansion fits with the necessary calculations are given in the original article. (E. V. David and W. S. Parr, Applied Engineering Dept., Air Reduction Sales Company, in *Machinery*, New York, vol. 38, no. 3, November, 1931, pp. 189–192, 2 figs., *p*)

MEASURING INSTRUMENTS

An Electromagnetic Vibrograph

THE purpose of this instrument is to measure vibrations produced by the object under test—for example, in overspeed testing of rotating parts of machines, such as turbo-generator rotors. Fig. 11 shows the fundamental diagram of this apparatus. *R* is a 3-watt valve oscillator. *E* is the receiver for the mechanical vibration, and *V* a 3-stage valve amplifier of 4-watt a.c. output. The indication is effected through the thermionic rectifier *G* by the d.c. recording ammeter *A* with paper speeds of 3, 60, or 180 mm. per min. The detailed apparatus is shown in other diagrams.

The method of measurement is illustrated by graphs in the original article. These show the excitation current of the trans-

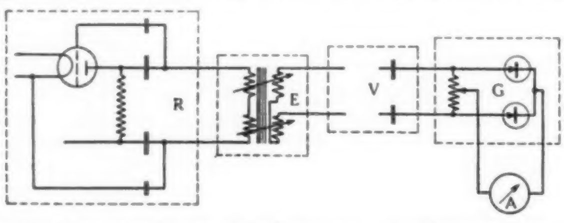

FIG. 11 SIMPLIFIED DIAGRAM OF CONNECTIONS OF ELECTROMAGNETIC VIBROGRAPH

[*A*, d.c. recording ammeter; *E*, vibration receiver; *G*, thermionic rectifier; *R*, valve oscillator (L.F. amplifier, 3 watts); *V*, valve amplifier (L.F. amplifier, 4 watts).]

formers in the oscillatory circuit of the valve generator, the frequency of which is about 500 cycles per sec. Next is shown the vertical component of a mechanical oscillation of the receiver base with respect to the pendulum. On the secondary side of the transformers medium-frequency voltages appear modulated by the mechanical oscillation, and at the output terminals of the amplifier currents occur which correspond to rectified currents in the instrument circuit; their average voltage value is recorded by the d.c. instrument as a deflection.

The range of the application of the complete apparatus is limited in an upward direction by the frequency of the exciting current and downward by the natural frequency of vibration of the receiver pendulum. The sensitiveness of the measuring arrangement is said to be amply sufficient for all cases. Such vibrations as of the order of magnitude of 0.01 mm. can still be easily read off. A special receiver is used for the measurement of large and therefore slow-running pole wheels. (F. Sieber, *Brown Boveri Review*, vol. 18, no. 8, Aug., 1931, pp. 248–251, and a large double sheet of graphs, *d*)

POWER-PLANT ENGINEERING (See also Internal Combustion Engineering: Bertin Gas Turbine)

A Turbine Rotating Device

A NEW auxiliary has been applied to one of the 100,000-kw. turbo-generators at the Long Beach plant of the Southern California Edison Company to serve two purposes. It is used to start the unit from dead rest without the use of steam, but its principal purpose is to rotate the spindle and shaft slowly when the throttle is closed so that they will not be warped by uneven cooling.

As pointed out by F. G. Philo, superintendent of steam generation, when a turbine is shut down and the spindle is allowed to come to rest, the lower part of the casing cools more rapidly than the upper half. Thus uneven cooling bends or distorts the spindle shaft. To start a turbine when this condition exists requires the greatest care, and under some circumstances starting must be delayed considerably. The rush of steam that must be admitted to a turbine to start the shaft turning tends to heat the spindle unequally and results in distortion. Before the rotating device was applied to the unit at least one and one-half hours was required to start. Since the application of the rotating device the unit has been put on the line in a third of that time.

In an emergency in which a large unit is needed on the line as quickly as possible, the time saved by the rotating device is immeasurably valuable. In addition to this starting advantage the rotating device serves largely to protect the turbine blading.

This auxiliary consists of a motor-driven train of gears operating through pawls on a toothed ring attached to the coupling between the turbine and the generator. The gear train is driven by a two-speed induction motor. At a motor speed of 564 r.p.m. the turbine shaft turns approximately $^2/_3$ r.p.m. and 5 hp. is required. At a motor speed of 950 r.p.m. 10 hp. is required to rotate the turbine shaft approximately $1^1/_3$ r.p.m.

To start the turbine from dead rest the low-speed winding of the motor is first used, switching to the higher speed before the throttle valve is opened. Oil is supplied to the bearings at about 20 lb. pressure by an independent motor-driven pump. (*Electrical World*, vol. 98, no. 13, Sept. 26, 1931, p. 551, *d*)

Steam Turbines

THIS is an abstract of a report of the Prime Movers Committee, Engineering National Section, National Electric Light Association, and comprises 1930 operating records for 324 large turbines, including the operating records for ten turbines operating above 1000 lb. gage steam pressure. The report further contains results of tests on five turbines ranging from 65,000 to 165,000 kw. capacity, and operating-company statements on the fouling of turbine buckets. Because of lack of space the report cannot be abstracted in detail, and only some of the particularly striking parts will be presented. Figures of comparison with the year 1925 show the great progress in the past half-decade. Thus the turbine-outage-factor curve for 1930 shows a decided improvement over that of 1925 for turbines of the same age. It should be particularly noticed that for the first time the 1930 curve shows that the outage factor for turbines in their first year of operation is lower than the factors of all the other operating groups, except those turbines which are thirteen years of age.

The number of units of 50,000 kw. capacity or more has increased from 42 in 1929 to 51 in 1930.

As regards high-pressure units, compared with the 1929 group the averages of the 1930 group operating at 550 to 1000 lb. gage indicate that this group had a lower demand factor for the year 1930, but operated at higher load factors while in use, as indicated by the higher output factor and lower service-hour factor. It is interesting to note a decrease in turbine outage and an increase in generator outage.

The reserve-hour factor, as might be expected from the lower demand factor, shows a big increase, being practically doubled.

The "h-p." group operating at more than 1000 lb. gage pressure has operating factors which compare favorably with the group of units operating from 550 to 1000 lb. gage, excepting the availability factor, which is the lowest for any group of units considered, having a value of 82.68 per cent. The outage factors for this group, moreover, are very high, the turbine outage being 10.68 per cent and the "other causes" outage factor being 8.55 per cent as compared with a turbine outage factor of 4.32 per

cent and an "other causes" outage factor of 0.66 per cent for the 550- to 1000-lb.-gage high-pressure group.

At various times member companies have reported difficulties due to fouling of turbine buckets that ranged from troubles merely necessitating cleaning the buckets at the time of annual inspection to very serious losses in capacity of 15 to 50 per cent and forced shutdowns. A number of statements from operating companies describing the troubles encountered and, in most cases, the remedy applied are presented as evidence that there is no one soverign cure-all, but that each case must be considered individually.

The consensus seems to be that all troubles of this nature may by prevented by properly controlling the condition of the boiler water, either by a change in treating methods, a reduction in the boiler-water concentrations, or the installation of devices to reduce or prevent moisture from entering the superheaters. In some cases the difficulties have been cured by the control of but one element of the boiler water.

The part dealing with tests of turbo-generator units is interesting but cannot be abstracted here because of lack of space. Likewise an interesting section which cannot be abstracted for the same reason deals with the reports of the various companies detailing the improvements which they made with their equipment in the last year. (Report of the *Prime Movers Committee, Engineering National Section, National Electric Light Association*, 1930, *Turbines*, 62 pp., 67 figs., *dceA*)

Attitude of Eleven Utilities Toward Welded Boilers

SEVERAL utility executives and engineering and operating department heads were asked (it is not stated by whom) three questions to ascertain the possible trend of welded-boiler acceptance, etc. Replies were received from eleven utilities listed in the original article and having an aggregate steam-generating capacity of 7,572,098 kw.

The first question was, "Would you agree to adopting power-plant boilers with welded drums and tubes if your engineers recommended them?"

The replies are summed up in the original article as follows: "We would not hesitate to use electrically welded drums and tubes when recommended by our engineers, provided the basis of their recommendations was sound." It would appear that none of the executives would accept the engineers' recommendations without being personally assured of the safety and service continuity of departures from customary practice. Five executives and six department heads expressed regret that there was anything in the Boiler Code to prevent the welding of boiler drums and tubes, as such experience as they had had in repairing boiler tubes, wall tubes, etc., by the welding process had shown that if the work was done properly it would be safe and satisfactory. As an advantage of welded and forged drums the absence of riveted butt straps was cited, resulting in the presence of fewer capillary spaces for the possible concentration of caustic soda. The fact that a welded or forged drum could actually be heat treated after fabrication likewise made it possible to be rid of unnecessary internal stresses often present in riveted drums.

The second question was, "What kind of evidence would you demand to assure yourself of the reliability of welded boiler drums and tubes?" One department head expressed a viewpoint quite characteristic of other engineers. He said, "The tests suggested by the A.S.M.E. code committee are, in my estimation, satisfactory and should not be reduced. I believe that, in the present state of the art, examination by X-rays is essential."

Generally speaking, the executive replies were that the tests should be of such kind and character as would remove any question of doubt as to reliability and safety. Complete elimination of the human factor in making the weld was recommended, but it was added that the only safe test is that of time. Tests should cover operating conditions, such as varying temperatures, stresses, and water conditions.

One executive, who was previously quoted as saying, "Our engineers are ready to recommend welded drums when they will be assured that the welding is dependable," added: "Of course, we would not adopt welded drums without extraordinary assurance of safety of the welding. We would call for an examination of the sample of the manufacturer's welding, would avail ourselves of the manufacturer's offer to X-ray the welds for their entire length, and of course would await approval by the A.S.M.E. code."

The third question dealt with help to bring about acceptance of the code dealing with welded-boiler construction. The replies, while interesting cannot be quoted because of lack of space, except for the following two which are characteristic.

One executive says: "We would actively help to bring about code acceptance if we had any very pressing need for this type of construction."

However, another executive replied that his company's co-operation in bringing about code acceptance would "depend entirely upon whether the economies were to go to the manufacturer or the purchaser." (*Electrical World*, vol. 97, no. 21, May 23, 1931, pp. 955–957, *p*)

Power

SIR Frederic Bramwell, a distinguished engineer of the second half of the 19th century, shortly before the end of his life in 1903, made provision for a lecture to be delivered before the British Association in 1931. Addressing that body in 1881 be prophesied that in fifty years' time the steam engine would only be spoken of as a curiosity to be found in a museum, as the gas engine was destined to become the prime mover of the future. The lecture of 1931 was to tell of the fulfilment of that prophecy, or otherwise, and it was Sir Alfred Ewing, president of Section G, Engineering, of the British Association, who was called upon to deliver it.

In the year following Bramwell's lecture Sir William Siemens, president of the Association, said, "Before many years we shall find in our factories and on board our ships, engines with a fuel consumption not exceeding 1 lb. of coal per effective horsepower per hour." The speaker added, however, that in these engines "the gas producer takes place of the somewhat complex and dangerous steam boiler."

The problem of the speaker of this year was to trace the history of the development of forms of power generation and to explain why the gas engine had not displaced the steam engine as expected by Bramwell. The two factors were, of course, the change of the steam engine from a reciprocating into a rotary unit, and the recognition of the limitations of the gas engine. It should be realized, however, that while steam is neither dead nor dying, but on the contrary has immensely developed both on land and sea, there have been wonderful achievements on the part of the internal-combustion engine which go far to justify the enthusiasm that stirred Bramwell fifty years ago. The gas engine itself did not develop as fast as those who had faith in it had hoped. The attempts to develop extremely large gas engines were for the most part costly failures. The big cylinders, cylinder heads, and pistons were apt to crack. The difficulty of controlling the temperature of the metal and the effects of unequal expansion stopped the construction of gas engines with large cylinders. Moreover it soon became clear that the chief advance of internal combustion was to take place on different lines, namely, by having oil serve as the internal fuel.

In 1887 Daimler applied his motor, using gasoline as a fuel, to drive a car on the road, and thus started a new era in locomotion.

Before long it gave the city streets an altered character and country roads an unsuspected value. In due course the gasoline engine also achieved the conquest of the air.

Another milestone in the history of internal combustion was the recognition that the efficiency of the action depended on the extent to which the combustible mixture in the cylinder was compressed before it was fired. In gasoline engines the compression could not be carried very far because of the danger of preignition, but about 1895 Rudolph Diesel applied his principle in a modified form to heavy-oil engines. Instead of compressing the combustible mixture he compressed the air alone, bringing it to a very high pressure and thereby making it so hot that when the charge of oil was forcibly injected at the dead point there was instant ignition. In this way all risk of preignition was eliminated and the efficiency of the action greatly augmented.

As regards steam, it was the compound steam turbine that gave steam a new life, and in this connection the speaker paid tribute to the great work of Sir Charles Parsons.

A return published in 1930 by the Electricity Commissioners (Great Britain) gives the aggregate capacity of the generative plant of various types as follows:

	Kilowatts
Steam turbines	5,531,952
Reciprocating steam engines	138,806
Oil engines	71,331
Gas engines	17,473
Water-power plant	42,208

It is seen that oil engines and gas engines together make up only $1^1/_2$ per cent of the whole. And it is the case that abroad, as well as at home, the steam turbine is dominant. Its dominance is the more appropriate because the turbine was invented in the first instance for the express purpose of driving a dynamo. Parsons realized, in the early eighties, that the generating of electricity gave steam a new job to do, a job that needed high-speed rotation, a job for which reciprocating movement was out of place. So he invented the turbine, in which high-speed rotation was a fundamental feature, and he invented also a high-speed dynamo suitable for it to drive, and he patented them both on the same day in April, 1884.

It is in the great power stations equipped with large turbines and coal-fired boilers using steam of high pressure and high superheat that the most economical production of power is found. This is due not only to the bigness of the units but to the fact that the turbine, as a thermodynamic machine, has permitted a far closer approach to the ideal cycle of Carnot than was possible in the reciprocating steam engine which, as Lord Armstrong said, skimmed the cream and threw the milk away. In the turbine the steam expands right down to the lowest vacuum that the condensing water will produce, doing effective work all the way and thereby saving a most valuable and previously wasted portion of the whole heat drop. The turbine approaches the Carnot cycle in still another notable respect, in that it allows a method of regenerative feed heating to be adopted in which some steam is bled at successive stages of the expansion to restore heat to the condensed water on its way back to the boiler.

In railway traction the supremacy of steam is maintained, and if the steam locomotive is driven out it will be probably replaced not by oil engines, but by electric traction. On the other hand, for road vehicles the internal-combustion engine is supreme.

In the field of ocean navigation the situation is puzzling, unsettled, and difficult to analyze. There is no sense of finality. There is even, it would seem, a good deal of fashion and caprice and of the probability of change which one associates with such moods of the mind.

In the Navy there is a practical monopoly on the part of steam, except, of course, in submarines, as well as in a new German cruiser—which is still something of a mystery ship—but the mercantile marine is in a state of flux.

Looking at the statistics of shipbuilding, a superficial observer might fancy that steam was in process of being driven off the high seas. Any conclusion to this effect, however, would be quite wrong.

As regards the marine field, all of the greatest and fastest ships are today steam driven, and this applies even to the newest vessels.

Of motor-driven ships, tankers, naturally enough, account for half of the world aggregate of motor tonnage launched in 1930. In vessels of intermediate types such as cargo liners and passenger liners of medium size, the liveliest contest between the steam turbine and Diesel motor is found. Here one notes the curiously potent influence of nationality. Some nations, such as Denmark, Norway, and Sweden, conspicuously favor motors; others, such as America, no less conspicuously favor steam. Both cannot be right. Nor can British practice, which is much divided, be right either.

"When we attempt," said Sir Alfred in summarizing, "to appraise the merits of the rivals and to estimate their chances in the more distant future, we see that from the thermodynamic point of view the Diesel engine still has a small advantage. On the other hand, its oil is more costly than fuel oil for boilers, it must have lubricating oil, too, and the first cost of the engine is substantially greater than that of steam plant. In respect of weight and of space occupied there is not much to choose; when account is taken of all accessories, there is perhaps a slight advantage on the side of steam. As to durability, I cannot speak; so far as I know, there is still a dearth of published facts about the cost of upkeep with Diesel engines. Prima facie, the great number of reciprocating parts is a serious drawback. There must be a great number because the safe limit of cylinder size is soon reached, and it is only by having many cylinders that any large aggregate of power is developed. In a recent Diesel-engined liner of the luxurious type, a ship of some 17,000 or 18,000 tons, twelve Diesel cylinders operate on each of four shafts, making forty-eight in all, to produce a speed of 18 to 20 knots. Besides these forty-eight main cylinders, there are twenty-four more which serve purposes that are auxiliary but essential to the working of the main engines. Consider the number of working joints, of valves, of valve rods and tappets, besides pistons and connecting rods, which this involves. Does such an accumulation of reciprocating pieces with their hammer-blow accelerations mark a real engineering advance as compared with the cosy hum of a turbine engine room, and has it come to stay? Frankly, I think not." (Sir Alfred Ewing, in Presidential Address before the British Association, Section G, Engineering; abstracted through *The Engineer*, vol. 152, no. 3951, Oct. 2, 1931, pp. 356–358, and editorial on p. 353, *g*)

STEAM ENGINEERING

Dimensions of Heated Tubes in High-Pressure Boilers

IN TUBES in steam boilers exposed to the action of heat in addition to the stresses induced in the walls by the existing pressures, other stresses are present which, as a rule, increase with the increasing thickness of the wall. As long as boilers were built with tubes of wall thickness not exceeding 5 or 6 mm. (0.19 or 0.23 in.) the supplementary stresses were not dangerous. Still some boiler builders took them into consideration in determining the size of the tubes.

The increase in steam pressures brought about by recent developments in boiler design, however, have made it necessary to employ tubes having heavier walls. In such tubes, particu-

larly those directly exposed to heat radiation in the furnace, the additional stresses referred to are becoming of a magnitude that deserves consideration.

Geo. A. Orrok in his paper, "High-Pressure Steam Boilers" (Trans. A.S.M.E., paper FSP-50-32), published for the first time some values of the heat stresses induced in the water tubes of modern boilers. Since then there have been several other publications in Germany and abroad.

In computing the sizes of boiler tubes it was formerly assumed that the heat was radiated from the furnace to the tube in parallel lines. This gave a distribution of heat over the periphery of the tube such that there was a maximum value at the front of the tube, and a correspondingly high stress in that part of the tube was computed. Since, however, it is not correct to assume heat radiation along parallel lines, the distribution of heat over the tube should show a wide, flat band in the front part of the tube. Konejung (*Wärme*, 1930, p. 891), however, has shown that the thermal stresses over the entire periphery of the tube are the same even when the heat loading of the tube is different. This makes it possible, notwithstanding actual variations in heat radiation over the periphery of the tube wall, to compute the supplementary stresses on the basis of a hypothesis in accordance with which the heat loading on the entire periphery is the same everywhere.

In water tubes in modern boiler furnaces which are exposed to actual radiation from the flame at the prevailing high temperatures, the average heat load over the periphery of the tube may be said to have a maximum of 200,000 kg-cal. per sq. m. per hr. (73,600 B.t.u. per sq. ft. per hr.). It will be later shown, however, that an exact determination of this figure is not important.

Lorenz has developed equations for the calculation of temperature stresses in hollow cylinders on the basis of Hooke's law. Duffing developed a simpler equation for the same purpose. If we assume that over the periphery of the tube there prevails an average heat loading of Q = 200,000 kg-cal. per sq. m. per hr. and that the material of the tube has a coefficient of heat conductivity k = 40 kg-cal. per sq. m. per hr. per deg. cent. (1 kg. cal. per sq. m. = 0.368 B.t.u. per sq. ft.) then the temperature difference between the outer surface (f in sq. m.) of the tube heated by the radiation and the inner water-cooled surface is

$$T_a - T_i = \frac{Q \times s}{f \times k \times 1000} = \frac{200{,}000\, s}{1 \times 40 \times 1000} = 5\,s$$

Under the above assumptions the temperature difference is about 5 deg. cent. per mm. (23 deg. fahr. per 0.1 in.) of wall thickness. This temperature difference causes an elongation of the outer fibers of the tube as compared with the inner fibers, and the pressure stresses acting outward reduce the tensile stresses, while the tensile stresses on the inside are added to the inner pressure. Of the forces acting in the three axial directions, only the tangential force is of interest, as it is the largest one. According to Lorenz the supplementary tangential stress of the inner fiber is

$$\sigma_i = \alpha G(T_a - T_i)AC$$

where α is the coefficient of thermal expansion for mild steel = $1.1 \times 10^{-5} + 0.8 \times T \times 10^{-8}$; G is the modulus of shear for mild steel, equal to 850,000 kg. per sq. cm.; T_i and T_a are the tube-wall temperatures on the inside and outside, respectively; $A = \dfrac{m+1}{m-1}$, where m = 3.33 (elongation over contraction of area); C is a constant $= \dfrac{2\beta^2}{\beta^2 - 1} - \dfrac{1}{\log_e \beta}$, in which $\beta = \dfrac{r_a}{r_i}$, the ratio of the radii of the tube. The coefficient of thermal expansion α, the ratio m, and the modulus of shear G depend on the temperature and the composition of the material of the tube. The temperature difference between the inner and outer walls depends on the heat conductivity which again is a function of temperature and the composition of the metal. Alloy steels, particularly those containing chromium, have a lower heat conductivity and therefore show a higher temperature difference under the same conditions than mild steel. Investigations on the effect of these factors are under way. The equations show that the highest temperature stresses in a heated boiler tube of which the external temperature T_a and the internal temperature T_i are determined by the temperature difference and the ratio of the radii in addition to the factor of the composition of the material. For water tubes in steam boilers the following values hold good for the constants A, C, and β in the Lorenz equation: β = 1.1 to 1.4, A = 1.855, and C = +1.032 to 1.111. The supplementary tangential tensile stress σ_i can be computed to be as follows: For a wall temperature of 250 deg. cent. (482 deg. fahr.),

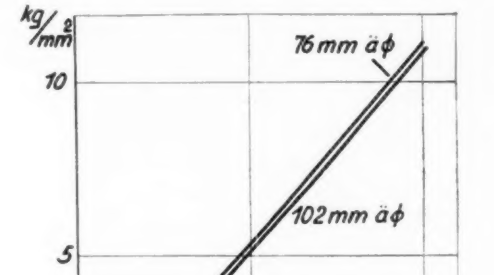

FIG. 12 THEORETICAL TEMPERATURE STRESSES IN EXTERNALLY HEATED PIPES COMPUTED ACCORDING TO LORENZ FOR A TOTAL HEAT LOAD OF 200,000 KG-CAL. PER HR. PER SQ. MM. (WANDSTÄRKE = WALL THICKNESS)

$$\sigma_i = \alpha G(T_a - T_i)AC$$

$$\sigma_i = 1.3 \times 10^{-5} \times 850{,}000\ (T_a - T_i) \times 1.86 \times C$$

$$T_a - T_i = 5\,s\ (s \text{ in mm.})$$

$$\sigma_i = 20.5 \times 5 \times s \times C \text{ kg. per sq. cm.}$$

The stresses of a heat load of 200,000 kg-cal. per hr. per sq. m. calculated for a uniform distribution over the periphery are given in the form of curves in Fig. 12.

From this it would appear that with the wall thicknesses quite commonly used today very high heat stresses occur, and these together with the stress produced by the internal pressure constitute total stresses in the tube wall which are above the elastic limit. The author plotted certain curves on the assumption that the behavior of the tubes would be in accordance with the above formula, an assumption, however, which in his opinion needs further consideration.

OPTIMUM WALL THICKNESS

The curves of Fig. 13 show the total stresses in a tube of a water-tube boiler 83 mm. outside diameter at heat loads of 50,000, 100,000, and 200,000 kg-cal. per hr. per sq. m.

In the part showing curves for 200,000 kg-cal. are also plotted

for the sake of comparison, the stresses produced in the pipe by the internal pressure alone. These show that where the higher pressures prevail the use of a material of higher strength gives lower theoretical total loads. The curves of total stresses have a certain minimum, and the wall thickness corresponding to this minimum has been denoted as the optimum wall thickness. Equations have been developed for the determination of this optimum thickness, and the German official regulations prescribe wall thicknesses lying in the region of the optimum. They have therefore also been described as the "most desirable." In the opinion of the author, it is fundamentally wrong to assume that the purpose of design should be to impose on a machine part only the minimum stresses. If a piece of machinery is subjected to only one stress and not to supplementary stresses which increase with its dimensions, then the optimum thickness of a part, for example, a column, will have to be infinitely great. In the original article the author gives curves which show how this false reasoning affects the dimensions of boiler tubes. As the heat load (and hence the supplementary stress) decreases, the wall thickness increases, and even at heat loads which correspond to those of the last rows of tubes in a boiler, the wall thickness assumes impracticable dimensions. This is unreasonable, however, because it does not take into account the properties of the materials and provides the same optimum wall thickness for all kinds of materials.

Were this true there would be no opportunity to make use

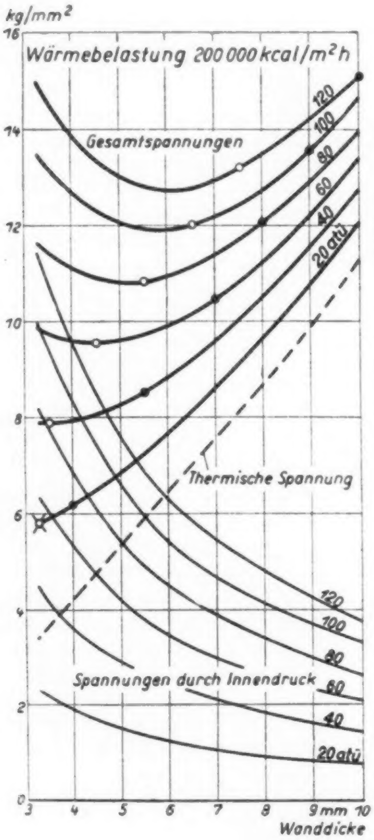
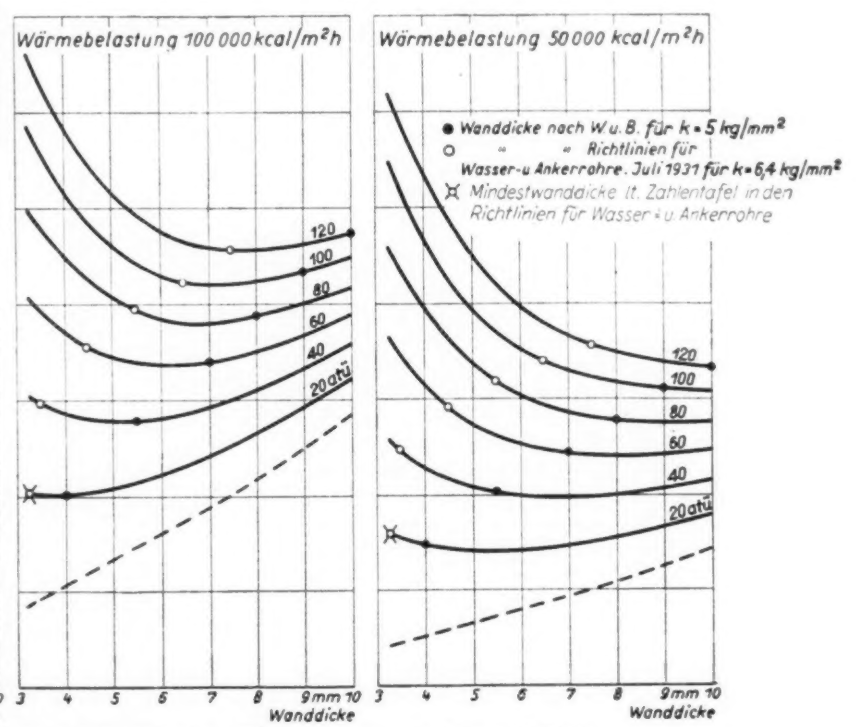

Abb. 3. Beanspruchungen eines Wasserrohres von 83 mm äuß. Ø.

FIG. 13 STRESSES IN A WATER TUBE 83 MM. O.D.

(*Wärmebelastung* = heat load; *gesamtspannungen* = total stress; *thermische spannung* = heat stress; *spannungen durch innendruck* = stresses due internal pressure; *wanddicke* = wall thickness; *wanddicke nach W. u. B. für k = 5 kg/mm²* = Wall thickness according to W. & B. for $k = 5$ kg. per sq. mm.; *richtlinien für wasser und ankerrohre, July, 1931, für k = 6.4 kg/mm²* = values for water tubes according to regulations of July, 1931, for a value of $k = 6.4$ kg. per sq. mm.; *mindestwanddicke lt. Zahlentafel in den richtlinien für wasser = u. Ankerrohre* = Minimum values of wall thickness according to tables in regulations for water tubes.)

of the tensile properties of special steels. A calculation of the total stresses occurring in pipes made of special steels where the higher strength of the material permits a correspondingly lower wall thickness, indicates that in such tubes the stresses due to the internal pressure are higher because of the lesser thickness of the wall of the tube, but the thermal stresses are lower than those in tubes made of ordinary steel. As a result the total stresses in the case of tubes made of high-tensile steels are lower than in tubes made of lower-strength steels, as shown by the author in a series of curves in the original article.

However, while the total stress does not differ very much with the kind of steel used, the elastic limit in alloy-steel (molybdenum and chromium-molybdenum) tubes is very much higher than in tubes of plain carbon steel, and notwithstanding the greater total load the ratio between stress and elastic limit is more favorable in the case of the special steels than in that of carbon steels.

The author suggests, therefore, that the term "optimum wall thickness" should be applied to that wall thickness at which the most desirable ratio is maintained between the total stress and the elastic limit of the material while hot, say, at about 400 deg. cent. (752 deg. fahr.) in the case of water-tube boilers. A still better plan in his opinion is to abandon the use of the term "optimum wall thickness," as it is a source of all kinds of errors and misunderstandings.

The author discusses next, largely on the basis of Orrok's work, the equalization of stresses, and then proceeds to the results obtained by the "Tubes" Group of the German Steam Boiler Board, one of the purposes of which is to work out new regulations for the dimensioning of wall thicknesses of heated boiler tubes. The purpose of the regulations which have been worked out and

which have received official approval is to reduce the wall thicknesses of boiler tubes exposed to heat. Contrary to the view that the most desirable wall thickness is the one which produces the lowest stress, the idea forming the basis of the new regulations has been that in the case of boiler tubes exposed to heat the material should be utilized in the most economical manner, which means that the wall thickness within the limits of safety should be determined by the elastic limit of the given material.

In the past only one magnitude of tensile strength, namely, 5 kg. per sq. mm. (7110 lb. per sq. in.) was used in the calculation of boiler tubes exposed to heat, without any regard to the kind of material. The new regulations provide the following formula for the calculation of wall thicknesses of water tubes and boilers: $s = (pd/200k) + 1$ mm. where s is the wall thickness in mm., d is the inside diameter of the tube in mm., p is the maximum operating gage pressure in kg. per sq. cm., and k is the permissible stress in kg. per sq. cm.

The following values are given for the coefficient k: For mild steel with an ultimate strength of 35 to 45 kg. per sq. mm., 6.4 kg. per sq. mm.; and for the same kind of steel of 45 to 55 kg. per sq. mm. ultimate strength, 8 kg. per sq. mm.

Where pipes made of alloy steels are employed the value of k is so selected that a factor of safety of 1.8 is provided as against the value of the elastic limit of the material at 400 deg. cent. (752 deg. fahr), but the wall thickness of water tubes exposed to heat should not exceed 8 mm. (0.314 in.).

It will be noted that heat stresses are not represented in the formula. The author lists the advantages of the lower wall thicknesses as follows: (1) Reduction of heat stresses in the wall of the pipe; (2) reduction of the outer temperature of the pipe; (3) increase in elasticity of bent tubes; (4) greater cross-section for water circulation; (5) lower weight of billets from which the tubes are made and hence better rolling ability of the billets; (6) ability to produce longer tubes; (7) better rolling of the material and reduction of faults; (8) lower wall-thickness tolerances and better ability to maintain the size of the tube; (9) easier handling in the installation and replacement of tubes; (10) superior ability for rolling in the tubes in the heads; (11) more economical utilization of the materials and hence lower prices of tubes for the same boiler pressures; (12) lower weight of boilers, which is particularly important on locomotives.

The author gives a table showing the formulas for wall thicknesses of boiler tubes in various countries, including the A.S.M.E. Boiler Code in the United States. (E. Lupberger in *Zeitschrift des Bayerischen Revisions Verein*, vol. 35, no. 16, Aug. 31, 1931, pp. 195–200, 6 figs., *ep*)

SPECIAL MACHINERY

Design of Rolls for Cold-Roll Forming Machines

THIS article deals with the design of rolls for shaping pipe and tubing by the cold-roll forming process. A large proportion of pipe has an electrically welded seam, but gas welding is also used to a considerable extent, due to the patent situation pertaining to electrically welded pipe.

The number of sets of forming rolls necessary to roll tubing is, of course, determined to a large extent by the diameter of pipe and the wall thickness, as well as by the tightness of seam required.

As tubing to be welded leaves the forming rolls with an appreciable gap between the ends, it is closed by a pair of rolls immediately preceding the welding operation, and is sized and straightened by additional rolls following the welding operation. The gap between the ends is used as a guide to insure that the seam will "track" as it goes under the welding electrodes, a roll which forces a tongue into the gap being used.

The opening left after forming is in line with the natural tendency for a roll-formed tube to open at the seam due to the spring-back of the metal opposite the seam, which cannot be formed past the finished arc without additional rolls. However, in the case of welded tube, this natural tendency works in the right direction and tubing suitable for welding can be rolled in from 4 to 12 sets of rolls for diameters from $^1/_8$-in. pipe size to 26 in. outside diameter by $^3/_4$ in. wall.

A number of different roll layouts are in use for the forming of tubing, all starting to form from the outside ends. One simply continues to roll up the stock about the same as in a curling operation, keeping the bottom flat until it is all absorbed by the radius, while another forms the center radius after a little more than 90 deg. is formed on the ends and then the remaining straight portion on each side is gradually worked into the circle, continuing from the outer end.

There is included a diagram of widths of flat strip necessary to form standard pipe from $^1/_8$ in. to 15 in., giving the blank widths, wall thicknesses, and outside and inside diameters of the pipe. This chart makes no allowance for additional stock for welding. (Third of a series of articles by D. A. Johnston, Roll Design Engineer, Kane & Roach, Inc., in *Metal Stamping*, vol. 4, no. 8, Aug., 1931, pp. 649–650 and 664, 1 fig., *p*)

VARIA

Life Characteristics of Physical Property

THIS bulletin presents a method of calculating the mortality curve, the probable-life curve, and the rate of renewals of particular examples and types of physical equipment. The method has been applied to 65 sets of original life data for property found in the following industries: water supply, telephone, telegraph, electric service, electric railway, steam railroad, agricultural implement, and motor vehicle.

Since the 65 mortality curves presented show very similar characteristics, they were redrawn so that the age was expressed in percentage of average life, and grouped into 13 classes, from which 13 type characteristic curves were drawn. Mathematical relationships of the various characteristics of both the original 65 curves and the 13 type curves are given in tabular and graphical form.

The 13 type curves can be used as valuable aids in forecasting the probable future service lives of individual items and of groups of items of different kinds of physical equipment. (Robley Winfrey and Edwin B. Kurtz, in *Iowa State College of Agriculture and Mechanic Arts Experiment Station Bulletin No. 103*, official publication, vol. 30, no. 3, June 17, 1931, 144 pages, numerous illustrations, *g*)

WELDING (See Power-Plant Engineering: Attitude of Eleven Utilities Toward Welded Boilers)

A Double-Flame Acetylene Welder

IN THE new Oxweld apparatus two flames are used—one for preheating the welding rod and the other for performing the actual welding operation. The former is so adjusted that the inner cone impinges directly upon the rod, preheating it practically to the melting point. Consequently little heat is required from the welding flame to melt the rod. The welding flame is directed between the vee (the plates to be welded are usually beveled to the vee) and the rod, so that the welding rod is melted and simultaneously fused with the base metal. (Description from a trade publication issued by The Linde Air Products Co., *d*)

Engineering and Industrial Standardization

Standard Safety Code for the Construction Industry[1]

RESPONDING to a long-standing demand for a uniform set of safety rules covering construction work of various kinds, the American Standards Association has authorized the organization of a sectional committee to formulate such a code. It has designated the National Safety Council and the American Institute of Architects as the joint sponsors.

The scope of this code, as discussed and approved at the first meeting of the Committee, held in Pittsburgh, is as follows:

"Construction, demolition, and repair of buildings, including excavation, foundation work, steel erection, scaffolding, lighting, openings, temporary floors and stairs, in relation to accident hazards to employees and to the public."

The purpose of the code is to be primarily educational. Such a document as is proposed should, when completed, summarize the best practices now in vogue throughout the construction industry. The adoption of the code by individual companies will be entirely voluntary, but it is anticipated that if the code has been carefully and effectively prepared, it will be immediately endorsed and observed by all of the leading companies, whose practices in this regard will in many instances exceed the specific requirements of the code; and to those companies who have not to date followed practices which are in the interest of safety on construction, the code will constitute a dependable guide developed by the industry itself. The prestige and influence of such a document, as time goes on, will increase as it is observed and supported by the construction companies, and thus in the most constructive and permanent way will other construction companies be induced to heed and observe its requirements.

One of the difficulties at present is the lack of the proper instrument for bringing to the attention of the small contractors usable and practicable information concerning the approved safe methods and policies as practiced by the larger and more progressive companies. The code will make the accomplishment of this possible. The second and equally important problem is that of bringing about a reduction in compensation-insurance rates.

Compensation-insurance rates are based on the accident experience of the industry. It is a well-known fact that at the present time construction-industry accident rates (both frequency and severity) are about twice as high as the average rates of all industries. This statement is predicated on the statistics compiled and tabulated last year by the National Safety Council. Is it not to be expected, therefore, that the insurance rates will be high? The code cannot of itself have any immediate effect on insurance rates, but all work of this character looks to the future, and in this instance should unquestionably prove to be a step toward the ultimate reduction of insurance rates because of the improvement that should come in accident rates as a result of the influence of the code. The code cannot, of course, be looked upon as a cure-all for the conditions now existing in the construction industry. It will need to be used in such a way that it will go hand in hand with other educational work of a consistent and permanent character, but without doubt a simple, workable code will be of considerable value in influencing those contractors formerly appearing to be uninterested in safety work of a constructive nature. This statement applies particularly to the smaller contractors who have evidenced unwillingness to adopt the safe methods and practices now employed by the larger and more progressive companies.

It is intended that the code be a simple, workable document. It will specifically call for the doing of those things which are already being done. It will not be idealistic. It will specify minimum requirements and not maximum. Such requirements will not prove to be a hardship on the progressive companies, but will definitely set forth the procedure to be observed for those companies that at the present time are unmindful of the risks that are being run or the hazards that exist on their work.

Personnel of the Committee

In accordance with the procedure of the American Standards Association the Committee includes representatives from the six different interests concerned: namely; (1) manufacturers of materials and equipment, (2) employers, (3) employees, (4) insurance interests, (5) governmental officials, and (6) technical experts.

The following organizations are represented on the Committee. The names of their official representatives are in parentheses after the names of the organizations:

American Institute of Architects (Samuel R. Bishop)
American Society of Civil Engineers (Leonard C. Wason)
The American Society of Mechanical Engineers (William A. Starrett)
Associated General Contractors of America (John W. Cowper)
Association of Governmental Officials in Industry (W. C. Muehlstein)
Building Officials' Conference (John W. Oehmann)
International Acetylene Association (representative to be appointed)
International Association of Industrial Accident Boards and Commissions (Charles R. Blount)
National Association of Builders' Exchanges (William Tubesing)
National Association of Building Trades Employers (Gerhardt F. Meyne)
National Association of Mutual Casualty Companies (William A. Dearborn)
National Bureau of Casualty and Surety Underwriters (Thomas J. Whelan)
National Safety Council (William R. Smith; W. Dean Keefer)
National Safety Council—Accident Prevention Equipment Manufacturers Section (Fred Davidson)
United States Bureau of Standards (Nolan D. Mitchell)
United States Department of Labor (John J. Hynes, William F. Kelly, and a third representative to be appointed)
Rudolph P. Miller (Member-at-Large).

Committee Organization

The following Committee organization has now been completed and the development of the various sections of the code is proceeding under the direction of the subcommittee chairmen:

Sectional Committee, W. R. Smith, Asst. Chief Engr., United Engineers and Constructors, Inc., Newark, N. J., *Chairman.* W. D. Keefer, Director, Industrial Safety Div., National Safety Council, Chicago, Ill., *Secretary.*

Subcommittee 1. L. C. Wason, Aberthaw Company, 80

[1] Abstracted from *ASA Bulletin.*

Federal Street, Boston, Mass., *Chairman.* Scope: Demolition.

SUBCOMMITTEE 2. Rudolph P. Miller, Consulting Engineer, 101 Park Avenue, New York, N. Y., *Chairman.* Scope: Excavation, foundation work, blasting, and compressed-air work.

SUBCOMMITTEE 3. J. W. Oehmann, Building Officials' Conference of America, Room 112A, District Building, Washington, D. C., *Chairman.* Scope: Scaffolding, ladders, temporary guard rails and toe boards, floor openings, sidewalk sheds, temporary stairs, runways and ramps, life lines, and safety belts.

SUBCOMMITTEE 4. W. A. Starrett, Starrett Corporation, Empire State Building, New York, N. Y., *Chairman.* Scope: Passenger elevators, material hoists, hoisting machinery, derricks, signals, cables, ropes, chains, blocks, barricades, and towers.

SUBCOMMITTEE 5. N. D. Mitchell, U. S. Bureau of Standards, Washington, D. C., *Chairman.* Scope: Steel erection, temporary floors, welding, and cutting.

SUBCOMMITTEE 6. W. A. Dearborn, Federal Mutual Liability Insurance Co., Boston, Mass., *Chairman.* Scope: Housekeeping, temporary lighting and wiring, salamanders, packing and storing materials, waste disposal, temporary sanitation, and first aid.

National Electrical Code

THE 1931 revision of the National Electrical Code (Cl-1931) which was approved as American Standard by the American Standards Association in August, has now been published and is available at five cents per copy. The code was prepared under the sponsorship of the National Fire Protection Association. It was published by the National Board of Fire Underwriters.

Copies may be obtained from the National Fire Protection Association, 60 Batterymarch Street, Boston, Mass.; from the National Board of Fire Underwriters, 85 John Street, New York, N. Y.; and from the A.S.A., 29 West 39th Street, New York, N. Y.

A.S.M.E. Boiler Code Committee Work

THE Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, 29 West 39th St., New York, N. Y.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and published in MECHANICAL ENGINEERING.

Below are given records of the interpretations of the Committee in Cases Nos. 687, 689, 692, and 693, as formulated at the meeting on September 18, 1931, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 687

Inquiry: Specifications S-3 for Steel Plates for Brazing provides that sheets less than $^1/_4$ in. in thickness need not be stamped at the mill, but that the manufacturer must mark each vessel in some permanent manner so that the material can be identified. None of the other material specifications have provisions of this sort. May not this same provision be interpreted as being applicable to all sheets under $^1/_4$ in. in thickness when made to any of the specifications in the Code?

Reply: It is the opinion of the Committee that sheets less than $^1/_4$ in. in thickness should not be marked with a steel stamp, and until such time as revisions can be made in those sections of the Code which permit the use of plates under $^1/_4$ in. in thickness, the provisions of Par. 6 of Specifications S-3 should apply.

CASE No. 689

Inquiry: a Why does Par. U-59 restrict the diameter of an opening into which a flange is seal welded to that found by the formula given, when Par. U-77 apparently permits a greater diameter for nozzles which are attached to the shell or heads by fusion welding?

b Can a nipple attached as shown in *C* of Fig. U-6, be up to 8 in. in diameter, on shell or heads of any diameters, small or large?

c Does not the attaching of flanges as shown in *A* and *B* of Fig. U-3 give a stronger connection than either *C*, *D*, or *E* in Fig. U-6?

Reply: a The formulas and rules in Pars. U-59*a*, U-59*b*, and U-59*c* are for plain unreinforced openings, such as tube holes and other drilled openings and connections where welding is applied for sealing and not for strength. The size of a fusion-welded nozzle is governed solely by the formulas and rules in Par. U-77. A welded-on flange or nozzle exerts a certain amount of natural reinforcing effect which can be realized only when the amount of welding is sufficient to transmit to the shell stresses capable of being developed by the flange or nozzle.

b Yes, except that the design should be such as to provide a factor of safety of 5, and on shells or heads 36 in. or greater in inside diameter, the diameter of the nipple is further limited by the rules given in Par. U-77. When the factor of safety is questionable, tests should be made in accordance with Par. U-51.

c While flanges shown in *A* and *B* of Fig. U-3 have mechanical locks, which better prevent them from being blown out of the vessel, they do not reinforce the opening made to accommodate them, since they are not welded for strength (see the reply above under *a*). Connections as shown in *A* and *B* of Fig. U-3 will be as strong as those shown in *C*, *D*, and *E* of Fig. U-6 if enough welding is added for strength.

CASE No. 692

Inquiry: Par. P-186 permits the use of electric-resistance butt welding under the Power Boiler Section of the Code, but no provision for such welding is made in the Unfired Pressure Vessel Section of the Code. Can this process of welding be employed in the manufacture of unfired pressure vessels?

Reply: It is the opinion of the Committee that electric-resistance butt welding complying strictly with the rules provided for this process of welding appearing in Par. P-186, may be used in the manufacture of unfired pressure vessels where the entire area is welded simultaneously. For temperatures higher than 700 deg. fahr. the working stress allowable on joints so made shall be reduced in proportion to the scale of reductions given in Table U-3. A revision of the Code for Unfired Pressure Vessels to this effect is contemplated.

CASE No. 693 (In the hands of the Committee)

MECHANICAL ENGINEERING

A Monthly Journal Containing a Review of Progress and Attainments in Mechanical Engineering and Related Fields, The Engineering Index (of current engineering literature), together with a Summary of the Activities, Papers, and Proceedings of

The American Society of Mechanical Engineers

29 West 39th Street, New York

Engineering Societies Library

SOME time ago we called attention to a number of important phases of the services of the Engineering Societies Library in New York. It has recently come to our attention that the Library translated the papers presented by foreign engineers and scientists at the Third International Coal Conference, which met at the Carnegie Institute of Technology, in November.

The translator of technical writings encounters many difficulties. Technical dictionaries are in general very defective, and, in addition, workers in advancing fields of knowledge constantly invent new words and new meanings for old ones. The translator must draw upon his knowledge of the subject for appropriate equivalents for these, for dictionaries give little help.

During its years of work, the Library has gained a reputation for accurate work. It is a source of pride and gratification to the members of the engineering societies that support the Library that the authorities in charge of the Coal Conference selected it for this important task.

A Patent Pool in the Radio Industry

AS A RESULT of extensive and troublesome litigation which has been plaguing the radio industry since its inception, representatives of that industry and of the U. S. Department of Justice are conferring in Washington with the idea of working out an arrangement under which the present difficulties may be ironed out.

One of the suggestions considered at this time is the formation of an open patent pool to control all patents in the radio industry, making them available to all who will use them on equal terms. This scheme is somewhat analogous to the cross-licensing patent agreement introduced under Government pressure during the war in the airplane industry, and since renewed along somewhat different lines by the industry itself. A cross-licensing agreement of a more limited character that does not apply to outstanding developments has been in existence for a number of years among the leading automobile manufacturers.

One of the contributing factors to the difficulties in the radio industry was the tremendous volume of new inventions, many of them of minor character, that were hidden in the Patent Office in the form of applications. The congestion in the Office has been greatly reduced in the last couple of years, but the number of applications in the radio industry has been so tremendous that delays in their consideration and prosecution for patents have been inevitable. So great has this congestion become that it is now practically the rule that under no circumstances shall any applications dealing with developments in the radio industry be made "special." Applications made "special" are considered ahead of the regular order.

The next development toward which the radio industry is looking is television, and there the patent problem is likely to be even more confusing. The situation is of interest, because the radio industry is not the only one suffering from an excess of patent litigation, and if it succeeds in finding a satisfactory way out, its experience may be valuable to the other engineering industries.

The fact that the Department of Justice is participating in the conferences might be taken as a partial guarantee that whatever scheme is finally evolved will not be in conflict with the so-called anti-trust laws.

Industrial Art

A RECENT exhibition of industrial art at the Metropolitan Museum of Art in New York serves to direct attention once more to the undoubted enrichment that modern technological developments in machines, materials, and processes has brought to the products of the handicrafts and the industries.

Man's use of machinery has not always been properly or artistically applied. The atrocities committed in the name of furniture construction—we shall not say design—sprang not only from the ability of a workman to use a jig saw and a turning lathe with grotesque effects, but also from his inability to express himself artistically with these tools.

When new materials become available to the craftsman and new devices such as lighting fixtures, radio cabinets, and household appliances and furnishings must be produced, designers flounder about in the fog of conventionalized art, or follow the will-o'-the-wisps of uncanonical fancy. A very real service is being performed by such agencies as the Metropolitan Museum in bringing together representative examples of contemporary industrial art so that tendencies may be studied, progress noted, and artistic impulses stimulated.

This year, repeating a successful experiment tried for the first time in 1930, the A.S.M.E. is holding an exhibition of art by engineers as a feature of the Annual Meeting. The exhibition will be confined to examples of the engineer's contribution to the fine arts. Behind the exhibition is a desire to express the fact that engineers have ability and appreciation in this field, and to encourage others to broaden their cultural interests. These objectives are most worthy. With the development of such individual interests, and with such exhibitions as that at the Metropolitan Museum showing what has been achieved in applying the sound principles of art to the mass production of machine-made articles, and to the artistic possibilities of new engineering materials and processes, it would seem that more

convincing arguments for the cultural value of modern technology would be difficult to find.

The British Election

THE LANDSLIDE in favor of the Conservatives in Great Britain in the October election is taken by every one as an indication that the country has abandoned, at least for the time being, the free-trade policy, and that a tariff on imports into Great Britain is about to be enacted.

The foundation for free trade was laid by Cobden and his associates at a time when England was a manufacturing country, probably the foremost in that line in the world, and the main imports that the tariff kept out were foodstuffs. This was the time when Hood in his "Song of the Shirt" exclaimed, "Oh, God! that bread should be so dear and flesh and blood so cheap!"

Places like Manchester and Leeds and the five towns were for free trade, because duty-free bread meant lower wages, and it was hoped that the free-trade idea might seep into the minds of customers abroad and thus contribute toward the increase of imports of British-made goods. Thus in the days of low wages and low purchasing power throughout the world, the problem of the manufacturers, among whom Great Britain stood foremost, was to find markets, which, in turn, meant to increase the purchasing power of the world. German competition in world markets began to be very keenly felt in the latter part of the 19th and in the first decade of the present century, and created a rabid feeling on the part of British manufacturers against goods "Made in Germany."

The years following the World War have brought about changes which have made the return to some sort of a tariff on the part of Great Britain imperative, and the only question today is what kind of a tariff will be decided upon. Certain features of such a tariff are already fairly clear. Barely had the news of the success of the Conservatives come over the wire than the Government of the Dominion of Canada suggested a revival of the idea of the Ottawa Conference. The avowed purpose of this idea was to promote trade within the British Empire by a system of preferential tariffs, but this, of course, could not be done as long as Great Britain adhered to a policy of free trade.

It is not quite clear as yet what effect tariffs will have on the trade between the United States and Great Britain. It is an important subject because Great Britain is one of this country's best customers, and it is certain that the tariffs of Great Britain will not be set so as to promote the foreign trade of the United States of America.

One factor in this situation must not be overlooked, and that is the effect of the abandonment of the gold standard by Great Britain and a number of European and South American countries. Depreciated money has always been an incentive toward manufacturing and exporting during the period immediately following the depreciation. If an Argentine trader is offered goods of the same quality and at the same nominal price by American and by British firms, to be paid for in full-value dollars in one case and in depreciated pounds in the other, it does not take long to find out who will get the business. Of course, the Britisher who sells goods in a depreciated currency really loses nationally, even though he may gain individually. Such a situation cannot continue indefinitely, but it can prevail for quite a while after the depreciation of the currency.

Incidentally, an excellent way to build up the gold reserve is by means of a tariff that requires import duties to be paid in gold or in its full equivalent. This method was used with success by Russia in the period preceding the reestablishment of the gold standard in 1896, and will probably be resorted to by Great Britain.

Opportunities for the Unemployed Engineer

ONE OF THE most regrettable incidents of the present depression is the large number of highly trained and fully competent engineers that are unemployed. These men have spent many years in honest service for some company and have only been let off when the finances and business prospects of that concern no longer warranted further employment.

The plight of such men in many cases is deserving of great sympathy from all fellow engineers. Realizing that they are without a job after long steady employment and further that no one else seems to want them, their psychological reactions are apt to be unfortunate. They see the future darkly. Their reserves, if they have any, are being used up and they feel absolutely helpless in the face of this economic disaster and of its effect on their future. Their plight has come about through no act of omission or commission on their own part. This attitude of hopelessness if allowed to persist can only lead to loss of confidence in oneself and to failure later when the depression has passed and opportunities for employment again prevail.

While these experiences test men's souls, this is no time for discouragement or despair. These unemployed engineers must face the competition of younger men when seeking new jobs. To be assured of employment, the older man must show that his training, experience, and technical knowledge are more valuable to the prospective employer than that of the younger man.

If the unemployed engineer would fully assure himself of his degree of superiority, let him take advantage of his idleness to prepare himself for his coming work. Much additional knowledge of the special elements of his particular branch of the profession has accumulated since his college days. Let him devote himself conscientiously for regular periods each day to the serious study of these new advances and to any necessary reviews of mathematics or other fundamentals that he may find necessary. Attendance at graduate courses in technical colleges is desirable if this can be managed.

If undertaken in all seriousness, this study will not only occupy his mind and tend to offset depressing thoughts, but will also reinspire him with a new confidence that he is becoming again a master of his profession. He will in truth be better prepared for his next job and will have the advantage of past experience which the younger man lacks.

But better than even this renewed confidence in himself will be the by-products of such studies in the form of new ideas. Such serious perusal of the latest developments in his line and of the modern concepts of physics and chemistry, must develop new ideas and new ways of applying these ideas. When he takes up engineering employment again, he will not only adopt the latest methods but his new ideas will lead to improvements and developments of the art in many directions.

Another suggestion is for the engineer to devote a large portion of his time to a study of his special field in an attempt to discover and develop still better the products that he normally produces. If he can later approach an employer with improvements that at once indicate merit, his chances of employment will be improved and his reputation enhanced by this useful development work done in his otherwise idle period.

Let us therefore urge every unemployed engineer to devote himself seriously to studies of this nature and to thus capitalize his idleness. It will pay and pay magnificently in the end in renewed confidence and hope, but principally in new ideas.

A. G. CHRISTIE.[1]

[1] Professor of Mechanical Engineering, The Johns Hopkins University, Baltimore, Md.

The Railroads Look Ahead

EITHER because of their belief in their essential invincibility or because of lack of vision, the railroads the world over refused at first to consider new methods of transportation as capable of hurting them. It was thus that the automobile traffic was allowed to cut into the passenger business of the railroad companies, while pipe lines and motor trucks gnawed away substantial portions of the railroad freight business, and a further threat began to take form in airplane transportation. From all indications, however, this complacent attitude on the part of the railroads is giving way to an earnest effort to retrieve their losses and incidentally to make of themselves more valuable agents of transportation. A few incidents in what appears to be a huge program of improvement and expansion of services will illustrate this change of attitude.

One of the advantages of the motor truck is that it takes goods at the door of the shipper and delivers them at the door of the consignee. The railroad runs merely from station to station. This makes it necessary to bring the goods from the shipper's warehouse to the railroad track, load them on to railroad cars, unload them at the station of the railroad destination, transfer them into another truck, and carry them to the consignee's address. In this way the railroads practically force the public to divide the business between the railroads themselves and their competitors, a choice which is usually not conducive to the railroads' success in the new fields of competition.

Now comes—as yet only in England—the Ro-railer, a hybrid between the railroad car and the motor truck, a vehicle that runs on highways to collect its freight and passengers, and when it comes to the railroad tracks, breaks out another set of wheels and takes to the tracks like a railroad car. Another plan under consideration is that of transporting ordinary motor trucks on special platform cars. These developments indicate that the railroad is willing either to get off the rails in order to get business, or to make its competitors pay for transportation, steam power being still cheaper than gasoline.

Faced with pipe-line competition, some railroads have awakened to the fact that they are ideally situated to provide space for pipe lines as they already have a graded right-of-way, bridges, etc., and can therefore lay pipes at a fraction of the cost that the pipe-line companies would have to pay.

The quest for new business in passenger traffic is proceeding along two main lines. The bus as a competitor of the railroad offers transportation at a lower price. The airplane threatens to provide faster transportation, probably at a higher cost. To meet this situation, the railroads are offering lower rates with the present accommodations or less expensive ones, which latter, while not so luxurious as the standard first-class transportation, will afford more comfort and a higher speed than bus travel, and at a price comparable with bus charges. From an engineering point of view, however, the most interesting development is in the direction of providing higher speed. Here remarkable improvements appear to be possible with standard means. Several railroads are laying plans for passenger-train speeds of the order of 75 to 90 m.p.h. This will make it possible for railroads to compete with airplane transportation as it exists today for distances up to about 1000 miles, which covers the major part of the passenger traffic.

But the railroads are not stopping at attaining high speed by conventional means only. In Germany the Kruckenberg car driven by airplane propellers and in Great Britain the Monorail bear promise of speeds in excess of 100 m.p.h.

It is an old story. Nothing is worse for an industry than a monopoly in its field. Fifty years ago the gas industry was exceedingly prosperous but was stagnating technologically. Then came Edison with the incandescent light, and the stocks of gas companies tumbled on the New York Exchange. Today, however, many times more business is being done by the gas industry than was ever done before the invention of incandescent light. The industry was forced by competition to get new business, first, through the development of the Welsbach mantle, then through the application of gas to domestic cooking, and more recently through large-scale industrial uses. Thus have beneficial and important technological improvements been developed under the spur of competition.

Those who think that the railroads are losing ground probably take a short-sighted view and do not give sufficient weight to the possibility that the railroads may be starting on a new career with the idea of going after business rather than graciously permitting it to come to them.

Faraday and Edison

THE CELEBRATION of the centenary of the birth of Michael Faraday in England and the recent death of Thomas Alva Edison in this country logically link together these two men whose contributions laid the foundations of modern electrical engineering.

When Faraday started his epoch-making studies, two methods of generating electricity were known—the static, through friction, and the galvanic, through chemical action. Neither of these bore promise of developments sufficiently important to affect the major trends of human life. In both methods of generating electricity actual contacts of materials were necessary. It remained for Faraday to conceive of invisible forces and of actions then imponderable, and to link together two forms of energy which, up to then, had been considered essentially independent of each other. The brilliant visualization of the magnetic field, the idea of expressing it in lines of force, and the further recognition that the cutting of the lines of force by a conductor would induce the flow of an electric current in that conductor, accomplished by Faraday, was an achievement all the more marvelous in that it was made at a time when the prevailing ideas as to electric currents and magnetic fields were hazy in the extreme.

Faraday unquestionably originated the electrodynamic machine, but he did not produce a commercial dynamo. Before this could be done the fog of misunderstanding and misconception about the working of the new apparatus had to be dispelled, particularly the idea formulated by some one out of thin air but believed to be true by the electrical engineers of those days, that the internal resistance of a generator had to be equal to the resistance of the outside circuit. This placed a theoretical limit of 50 per cent on the efficiency of the ideal electric generator.

Crude and obviously untenable as this seems to us now, it was accepted without question by every one at that time, and it remained for the practical genius of Edison to realize that current generated by a dynamo should be consumed as far as possible in the outside circuit, where it could do useful work, and not be transformed into heat in the interior of the generating machine. From this came the early Edison generators with efficiencies of more than 80 per cent, that is, far beyond what was then considered the maximum possible theoretical efficiency of the machine, and it was only because of the availability of these efficient generators that the growth of practical applications of the electric current became possible.

The electrical engineer of today has departed from the paths laid out by Edison. Instead of Edison's direct-current "Jumbos," huge alternators now generate our electric current. But after all, the generation is by means of an alternator in both

cases. With the exception of the unipolar machine, all electric generators produce an alternating current in their armature windings. This can be taken off as such, or can be rectified into direct current by means of a commutator. Thus the two fundamental principles of electrical energy laid down by Faraday and Edison are still true and substantially unchanged in every generator of today. These principles are the creation of electric current by the cutting of lines of force by conductors or the cutting of conductors by lines of force, which was Faraday's contribution, and the reduction to a minimum of the internal resistance of the generator, for which the world has Edison to thank.

Engineers and Unemployment

ENGINEERS generally, no less than other groups of individuals, will have good reason to look back upon 1930 and 1931 as a period in which they were caught in a particularly disastrous turn of fate. What with lifelong jobs lost, income and salaries cut, programs of development in which they took an exceptional professional pride deferred, associates and employees shaken in their faith and morale, their mental suffering is now acute. To most of them what looks like a shattering of economic and social ideals has taken place and the integrity of what amounted in many cases almost to a religion—belief in science and the abundant productive capacity they had built up—apparently has been impeached. To add to their undoubted personal distress, in many cases amounting to hopeless despair, they must listen to the accusations of those who attribute a large share of the burden for our present difficulties unfairly, we believe, to technological reasons. This, to men who have sincerely believed that their labor-saving devices were bringing incalculable benefits to their fellows, has had a crowning dispiriting and crushing effect, for they feel that they have been betrayed, not by their own ideals, but by the general incompetence of human nature to make wise use of the industrial system. Their lot is that of those who have outstripped their fellows in the attack on the outposts of future developments and who are now, provisionless and cut off, left to perish as a consequence of their rashness. And many of them feel that by the time reinforcements arrive they will find themselves unable again to lead the advance. In his particularly sympathetic view of this situation, printed on page 941 of this issue, Professor Christie has pictured the distress felt by those who are out of work and gives some suggestions for them to follow in the emergency. Engineers who still retain their jobs express the deepest concern for and sympathy with their less fortunate but just as worthy brothers. Opportunity will not be lacking for these engineers to translate those sentiments into practical forms while the effects of economic maladjustment are most acute. The time will soon be here, if signs of hope appearing on the horizon are not wholly illusory, for these same engineers to give more concrete evidences of sincerity and helpfulness by re-employing as rapidly as possible those who are now without work. The opportunity exists for practical demonstrations of professional consciousness and solidarity.

An agency through which engineers find a means of expression and common action is the American Engineering Council. During these dark months this organization has been actively concerning itself with the immediate problems presented by unemployment and with the more fundamental problem of guarding against the recurrence of such serious economic depressions as the present one and coping with them more effectively in the future, should they develop. A brief outline of the report of the Council's Committee on Relief From Unemployment, of which F. J. Chesterman is chairman, was printed in the October 22 issue of the *A.S.M.E. News*. For it we bespeak the serious consideration of every engineer, whether employed or not, and a sympathetic and helpful response. The comprehensive program with its dual purpose of present and future remedies should engage the interests of every one.

Samuel Wesley Stratton

SAMUEL WESLEY STRATTON, whose death occurred with dramatic suddenness following the dictation of a tribute to Thomas A. Edison, will be remembered as the genius behind the United States Bureau of Standards from the time of its inception until recent years. He became the Bureau's first director after its creation by law on March 3, 1901, and to him has been given a major portion of the credit for bringing about its establishment. His services as president, and later as chairman of the corporation, of the Massachusetts Institute of Technology, crowned a useful career devoted to the advancement of applied science.

SAMUEL W. STRATTON

Dr. Stratton's success lay quite as much in his knowledge of human nature and his ability at organization as it did in his knowledge of science and his ability at research. A combination of these qualities fitted him to perform an unusual task, one that required vision and enthusiasm to maintain it upon a high level, and a certain practical working knowledge of how to accomplish results in the face of indifference and the handicaps that confront governmental bureaus.

It was, perhaps, this characteristic that makes engineers proud to confess him as one of their own, for it is such a combination of knowledge of nature and human nature that makes it possible for engineers to accomplish their high purpose.

Viscount Shibusawa

VISCOUNT SHIBUSAWA, honorary member of the A.S. M.E., the "grand old man" of Japan, who as a young man assisted his country to adjust itself to association with other nations and to an acceptance of western ideas of industrialism and foreign trade, and who as one of its great leaders lived to see his people take their place with those of Europe and America in a rapidly developing industrialization of civilization, is dead. Engineering, finance, and international relations will mourn his passing, for his influence and his achievements in these fields were great and significant. This country in particular has lost a staunch and understanding friend.

Almost coincidentally with this sad event there has come to this country a memorial volume, "Dr. Sperry as We Knew Him," beautifully bound and abundantly illustrated, containing nearly 500 pages in Japanese and in English that tell of Dr. Sperry's life and work in terms of highest praise and appreciation—truly a remarkable tribute to one of our great inventors. Viscount Shibusawa, long friend of Dr. Sperry's, was one of the 34 contributors to this volume. If there could exist with all men the same degree of sympathetic understanding of men and nations that Viscount Shibusawa and Dr. Sperry possessed, the long-hoped-for era of universal peace soon would dawn.

Book Reviews and Library Notes

THE Library is a cooperative activity of the A.S.C.E., the A.I.M.E., the A.S.M.E., and the A.I.E.E. It is administered by the United Engineering Trustees, Inc., as a public reference library of engineering and the allied sciences. It contains 150,000 volumes and pamphlets and receives currently most of the important periodicals in its field. It is housed in the Engineering Societies Building, 29 West 39th St., New York, N. Y. In order to place its resources at the disposal of those unable to visit it in person, the Library is prepared to furnish lists of references on engineering subjects, copies of translations of articles, and similar assistance. Charges sufficient to cover the cost of this work are made.

The Library maintains a collection of modern technical books which may be rented by members residing in North America. A rental of five cents a day, plus transportation, is charged. In asking for information, letters should be made as definite as possible, so that the investigator may understand clearly what is desired.

Onward Industry!

Onward Industry! By James D. Mooney and Alan C. Reiley. Harper & Bros., New York, 1931. Cloth, 6 × 9 in., 564 pp., $6.

Reviewed by Henry P. Kendall[1]

THE authors have attempted to deduce the principles by which human beings organize and carry on their joint activities. They have analyzed church organization, military organization, government, and industry, and have tried to arrive at common principles from these. They have given concrete definitions to terms on which in the past there has been confusion. This is a real contribution.

In the latter part of the book they analyze industrial organization, trying all the time to deduce principles which would be generally applicable. They fix on management the responsibility which belongs with management opportunity. They show themselves liberal and progressive.

I feel that they have made a contribution in their studies of organization, although an experienced student of the subject finds very little that is new.

American Diesel Engines

American Diesel Engines. By L. H. Morrison. McGraw-Hill Book Co., Inc., New York, 1931. Cloth, $5^3/_4$ × 9 in., 606 pp., 387 figs., tables, $5.

Reviewed by Oliver F. Allen[2]

TO THE student who wishes to learn of the history of Diesel developments and to find in a single volume a comprehensive and impartial exposition of the present state of the art in America, as well as to the older engineer who wants to refresh his recollections as to what has been done and what is practicable, Mr. Morrison's book can be of great service. It is written in a clear, human way, with occasional shrewd comments on present practices and common errors which make it not only interesting but valuable in pointing out things to be avoided in manufacture, installation, and operation. For example, in the introduction the disadvantages of restricted intake are emphasized, and in the chapter on Diesel fuel oils are constructive suggestions regarding the use of heavy oils.

If large marine engines are included, it is doubtful if the production in the United States, measured in total horsepower capacity during, say, the last three years, equals that of some other countries, but it is gratifying to have this author show that we are in the front rank in oil-engine manufacture. He has understated the number of Diesel locomotives in service. This is a rapidly growing field which might have been given more space. Considering the hot-bulb engine as a parent of the present Diesel, as the word is now used, the author might have said a little more about the early work of the De La Vergne Company with their Hornsby-Akroyd engine and that of Venn-Severin in Chicago.

It is a pity that two chapters, covering more than fifty pages, were devoted to fuel valves and pumps for air injection, now that solid, or mechanical, airless injection is almost universally replacing air injection, but no doubt the author felt that the number of such engines in use and still being built in the United States justified it. In the chapter on engine output more could have been said about foreign indicators which are available, and typical actual diagrams, which had not been smoothed out, included for the guidance of students and operating engineers; but as it is, this chapter is recommended to any one who has to verify output, or to compare machines of different types.

It is a pleasure to note Mr. Morrison's prediction of the increasing use of the two-stroke-cycle engine. He is to be congratulated on his impartiality and on the comprehensive way in which he has treated the American Diesel-engine situation.

Theory of Heat Engines

The Theory of Heat Engines, Including the Action of Muscles. By J. S. Haldane. Oliver and Boyd, Edinburgh, 1930. Cloth, 5 × $7^1/_4$ in., 120 pp., 3 figs., 6s.

THIS is the kind of a book that not only contains information but makes one think. Among other things, the author claims that the reversible heat-engine cycle is not only an ideal conception but also an impossible one, and neither corresponds with the phenomena in an actual heat engine nor with the nature of heat itself.

The author claims that he has endeavored in his book to give a theoretical account of heat engines as they actually exist or may exist, taking into consideration essential facts well known empirically to engineers. For the conceptions of Carnot and Kelvin as to the possible thermal efficiency of heat engines, he says, there is no longer any place.

The source of Carnot's mistakes, according to Haldane, lies in his failure to realize the significance of the fact that heat is something which is constantly leaking in all directions to and from the structure of the engine as well as to the outside. Carnot

[1] President, The Kendall Company, Boston, Mass.
[2] Consulting Engineer, New York, N. Y. Mem. A.S.M.E.

also did not realize the difference between a gas engine and a steam engine. It is with respect to the steam engine particularly that the author differs from the conventional view. In fact, if the conclusions reached in this book as to the potential thermal efficiency of steam engines are correct, coal in the solid state would appear to be much more valuable as a source of power than has yet been realized, and its capacity for generating mechanical or electrical power as great as that of liquid or gaseous fuel of corresponding calorific value.

The chapters dealing with the muscular system as a heat engine will prove only of incidental interest to the mechanical engineer.—L. C.

Science in Action

SCIENCE IN ACTION. By Edward R. Weidlein and William A. Hamor, of the Mellon Institute of Industrial Research. McGraw-Hill Book Company, Inc., New York, 1931. Cloth, $5^3/_4 \times 9$ in., 310 pages, 32 illus., $3.

REVIEWED BY A. A. POTTER[3]

THIS book includes in part material which the authors have presented during the past fifteen years in addresses and articles in their effort to interpret scientific-research progress. The sixteen chapters of their treatise have been arranged in six parts, in addition to an introductory chapter which deals with the groundwork of industrial research.

Industrial research is the fact-finding agency of industry, and aims through scientific investigation to find new materials, new processes, and new uses of products. The scientific investigator discovers, and the engineer recognizes and applies the results secured. The authors define engineering as "the art of the economic application of mathematics, physics, and chemistry to the purposes of man," and state that "engineering as we know it was born about 1750, the child of the industrial period," while industrial research "attained its present position of high importance when scientific management, its patron, took the direction of technology in 1921."

John Winthrop, Jr., who landed in Boston in 1631, is credited as being the first industrial-research worker of America. President Washington, in his first annual address in 1790, stated that "there is nothing which can better deserve your patronage than the promotion of science." One of the most valuable parts of the book is that pertaining to the development of industrial chemical research from the time of Professor Woodhouse in 1795 up to the World War.

In discussing the present status of industrial research the authors present the findings of several surveys "that sought to learn the extent to which science is being utilized in advancing manufacturing." Some 1600 industrial research laboratories are expending in the U. S. A. about 155 million dollars a year for new knowledge, and the expenditures are looked upon by many of these organizations not only as a profitable investment but also as an absolute necessity for continuing business success.

One section of the book is devoted to science and human welfare. Under this heading are included the studies which have as their objectives air and ventilation, smoke and dirt abatement, proper sleeping equipment, safe water, pure foods, and improvements in the practice of medicine and pharmacy.

Examples are given of the contributions of science to agriculture, the cottonseed-oil industry, corn products, sugar, textiles, dyes, paper, leather, petroleum, electrical lighting, X-rays, and communication.

[3] Dean of Engineering, Purdue University, Lafayette, Ind. Mem. A.S.M.E.

The very rapid advance of industrial research is attributable to its economic soundness. Examples are given of the results accomplished by scientific research in the iron and steel, electrochemical, rubber, and cement industries, and in coping with water, refrigeration, and fuel problems.

Research to reduce waste is discussed, and some of the problems awaiting solution are pointed out.

Synthesis, the industrial preparation of chemicals by combining elements or their derivatives into definite compounds, is shown to give rise to entirely new branches of manufacture, such as carbon black and ammonia from natural gas and chemicals from acetylene.

The importance of research in industrial management is pointed out with particular reference to standards, the manufacture of new products, industrial hygiene and safety, merchandising, new uses for old and obsolescent products, containers and packages, distribution, and personnel problems. "Without this triple alliance of the research scientist, alert manager, and skilled operative, no industry can expect to be in the van of technical progress." "The outstanding features of industry today are division of labor, specialism, mass production, scientific management, and scientific research." Examples are given of the achievements of science in lowering production costs, while bringing about new opportunities to labor.

The authors state that "bankers have become science-minded. They know that good prospects in an industrial investment are dependent upon good management, and that management can be made strong and progressive by research."

The last section of the book is devoted to industrial research methods and men.

Drs. Weidlein and Hamor have produced a very useful book setting forth in clear language the accomplishments of industrial research.

Books Received in the Library

AIR NAVIGATION. By P. V. H. Weems. McGraw-Hill Book Co., New York, 1931. Leather, 6×9 in., 589 pp., illus., diagrams charts, tables, maps, $5.

In this text, the author has endeavored to assemble all the material needed to produce a practical air navigator. Pilotage, dead reckoning, aerology, radio position finding, and celestial navigation are covered. Attention is concentrated on modern rapid methods which can be used in the cockpit. The use of celestial observations and radio bearings is emphasized.

CONQUEST OF SPACE. By D. Lasser, with introduction by H. H. Sheldon. Penguin Press, New York, 1931. Cloth, 6×8 in., 271 pp., illus., diagrams, $3.

This is the first book in English to tell what has been done to develop the rocket for propulsion and to discuss the possibilities of its utilization for terrestrial and interplanetary transportation. The work of various experimenters is described, the problems are pointed out, and a fanciful picture given of a journey through space. The author, the president of the American Interplanetary Society, writes for non-technical readers.

DAVISON'S TEXTILE BLUE BOOK, 66th Year. Davison Publishing Co., New York, 1931. Cloth, 5×8 in., 1454 pp., illus., maps, handy edition, $5.

This well-known directory covers the American textile industry thoroughly, giving the information usually needed by merchants, salesmen, mill owners, etc. Mills, dyers and finishers, commission merchants, converters, dealers in yarn, fibers, waste, etc. are listed, with information as to their officers, products, and equipment. Dealers in textile materials and users of them will find this directory very valuable.

DIESEL REFERENCE GUIDE. By Julius Rosbloom. Industrial Institute, Inc., Jersey City, N. J., 1931. Cloth, 8 × 10 in., 300 pp., and Directory of Manufacturers (60 pp.), illus., diagrams, charts, tables, $10.

Data on various types and makes of Diesel engines given in this book include principles of construction and operation, and problems of Diesel-engine practice. Accessories essential to operation are treated in a complete manner. Rules and regulations of supervising institutions are given, together with instruction on modern Diesel-engineering, land, marine, locomotive, aero-service, automotive, and portable duties. C. W. S.

DER EINFLUSS VON BOHRUNGEN AUF DIE DAUERZUGFESTIGKEIT VON STAHLSTÄBEN. By G. Barner. V.D.I.-Verlag, Berlin, 1931. Paper, 6 × 9 in., 50 pp., illus., diagrams, charts, tables, 5.50 r.m.

As part of an extensive investigation of riveted joints, the author has studied the effect of drilled holes upon the fatigue strength of different steels. The effects of roll skin, drill holes, and the finish of holes were determined. The results are reported fully. The work of earlier students is also reviewed.

ELASTIZITÄTSTHEORIE DES STARREN LUFTSCHIFFS. (LUFTFAHRTFORSCHUNG, vol. 9, pp. 57–84, No. 2, 1931.) By E. Seydel. R. Oldenbourg, München, 1931. Paper, 8 × 12 in., diagrams, charts, tables, 5.80 r.m.

This number presents a method for the static design of rigid airships which was presented to the Prussian Academy of Science in 1915 by the late Heinrich Müller-Breslau, but which had never been published. The method, which is unusually simple, is published from a manuscript found among the papers of the author.

EINFÜHRHRUNG IN DIE MECHANIK FESTER ELASTISCHER KÖRPER UND ZUGEHÖRIGES VERSUCHSWESEN. By R. Girtler. J. Springer, Vienna, 1931. Cloth, 7 × 10 in., 450 pp., illus., diagrams, tables, 29 r.m.

This textbook presents the course in elasticity and the strength of materials given by Dr. Girtler to students of engineering and technical physics at the German Technical University in Brunn. A knowledge of mechanics, higher mathematics, and vectors is assumed. The first half of the book is devoted to the general principles of experiment and theory; the second to theories of approximation for the calculation of straight beams.

ENTZÜNDUNG UND VERBRENNUNG VON GAS- UND BRENNSTOFFDAMPFGEMISCHEN. By W. Lindner. V.D.I. Verlag, Berlin, 1931. Paper, 6 × 9 in., 85 pp., illus., diagrams, charts, tables, 7.50 r.m.

This pamphlet aims to give a clear explanation of the phenomena of power generation in the cylinder of a gas engine. The chemical reactions that occur during the combustion of hydrogen, carbon monoxide, and hydrocarbons are described, as are also the velocity of ignition, the propagation of the flame, and other physical phenomena. A special section is devoted to knocking. A useful bibliography is included.

FRACTIONAL HORSE-POWER MOTORS. By A. H. Avery. Isaac Pitman & Sons, London and New York, 1931. Cloth, 5 × 8 in., 152 pp., illus., diagrams, charts, tables, 7s.6d; $2.25.

The essential features of motors with power outputs of less than one-half horsepower are presented concisely. Design, constructional features, commutation, and insulation are discussed. Testing and repairing are also considered.

GEDANKEN ZU EINER WELTANSCHAUUNG VOM STANDPUNKTE DES INGENIEURS. By A. Stodola. J. Springer, Verlag, Berlin, 1931. Paper, 7 × 10 in., 100 pp., diagrams, 10 × 7 in., 4.50 r.m.

In these essays and addresses upon such subjects as the glories and perils of engineering, the triumph of the intellect and its limits, biology as an exact science, and the riddle of life, Dr. Stodola gives us his matured views as to the meaning of the universe and the purpose of man. Addressed especially to young engineers, his views on these great questions will be stimulating to every reader.

DIE GELENKMETHODE. By S. A. El-Wahed. J. Springer, Berlin, 1931. Paper, 6 × 10 in., 45 pp., illus., diagrams, charts, tables, 4.50 r.m.

Describes a new method of solving problems of indeterminate structures by means of models of celluloid or cardboard, for which greater accuracy and more general applicability than those of former methods are claimed. The book presents theoretical bases of the method, describes the construction of models, and illustrates the application to frameworks and elastic plates.

HEAT ENGINES. By J. R. Allen and J. A. Bursley. Fourth edition. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 538 pp., illus., diagrams, charts, tables, $4.00.

An elementary presentation of the essential principles of steam engines, boiler plants, internal-combustion engines, steam turbines, and their auxiliaries, intended for use as an introduction to the advanced study of heat engines. This revision contains new material upon boilers and boiler-room equipment, turbines, and internal-combustion engines.

HISTORY OF AIRCRAFT. By F. A. Magoun and E. Hodgins. McGraw-Hill Book Company, Whittlesey House, New York, 1931. Cloth, 6 × 9 in., 495 pp., illus., tables, $5.

The authors have attempted to give a complete record of the art of aeronautics in a single volume and have accomplished their aim with brilliant success. In successive sections they trace the development of balloons and airships, of ornithopters, helicopters, gliders, and airplanes, from the earliest times to today. Many fine illustrations add to the interest of the book, and a valuable bibliography is included. The style is unusually clear and readable.

INDUSTRIAL ENGINEERING AND MANAGEMENT. By R. M. Barnes, McGraw-Hill Book Co., New York and London, 1931. Cloth, 6 × 9 in., 366 pp., illus., diagrams, charts, tables, $3.50.

The fundamental principles are here presented with concrete illustrations drawn from successful industrial practice. Six chapters are devoted to factory design and equipment, seven to time and motion study, wages and manufacturing costs. The method of designing a new manufacturing plant is described in detail in an appendix. A useful select bibliography is included.

INTERNAL-COMBUSTION ENGINES. By H. E. Degler. American Technical Society, Chicago, 1931. Cloth, 6 × 9 in., 159 pp., illus., diagrams, charts, tables, $2.00.

An elementary textbook, largely descriptive in character and suited to the needs of home students. Attention is confined to the engines and auxiliaries in common use today.

JAHRBUCH 1931 DER DEUTSCHEN VERSUCHSANSTALT FÜR LUFTFAHRT, E. V., Berlin-Adlershof. Edited by W. Hoff and others. R. Oldenbourg, Munich and Berlin, 1931. Cloth, 8 × 12 in., 745 pp., illus., diagrams, charts, tables, 62 r.m.

This yearbook reviews the work of the German Experiment Station for Aviation during the past year. Two hundred and sixty investigations are summarized in abstracts, and fifty-eight of the more important are published in full. Among the latter are model tests on the artificial ventilation of engine test-benches, test drives of propeller-driven railroad cars, several investigations of the structural requirements of aircraft parts, supercharger tests, tests of waste-gas propulsion, and studies of knocking. Other papers discuss the welding of aircraft parts, the strength of

various light alloys, the properties of finishes, and the corrosion of metal sheets and wires.

JAHRESBERICHT 1931 DER STOFF-ABTEILUNG DER DVL. SONDERDRUCK AUS DEM JAHRBUCH 1931 DER DEUTSCHEN VERSUCHSANSTALT FUR LUFTFAHRT, E. V., Berlin-Adlershof, pp. 379–566. By P. Brenner. R. Oldenbourg, Munich and Berlin, 1931. Paper, 8 × 12 in., illus., diagrams, charts, tables, 14 r.m.

This yearbook presents the investigations completed during the past year by the Materials Division of the German Experiment Station for Aviation. Among these are investigations of the use of welded steel pipe in airplanes, the static and dynamic strength of some light alloys, methods of testing corrosion, the corrosion of light alloys, the weathering of lacquers, and the testing of engine materials.

KINEMATICS OF MACHINERY. By C. D. Albert and F. S. Rogers. John Wiley & Sons, New York, 1931. Cloth, 6 × 9 in., 527 pp., illus., diagrams, charts, tables, $4.50.

This textbook is based upon the course given to engineering students at Cornell University but contains advanced material, in addition to that included in most courses, upon velocity and acceleration vector diagrams, cams, and spur gears. The treatment is concise, yet thorough, and many problems are included.

LABORATORY HANDBOOK OF STATISTICAL METHODS. By T. H. Brown, R. F. Bingham, and V. A. Temnomeroff. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 244 pp., diagrams, charts, tables, maps, $2.

The first book of this work gives a very clear description of the construction of graphs for business purposes, explaining the graphs commonly used and their uses. Book two outlines the purpose of certain statistical methods and illustrates their use by the solution of practical problems.

MITTEILUNGEN AUS DEN FORSCHUNGSANSTALTEN, GHH-Konzern, Vol. 1, No. 6, pp. 123–146, July, 1931. V.D.I. Verlag, Berlin. Paper, 9 × 12 in., illus., diagrams, charts, tables, 3 r.m.

These reports from the research departments of various German machine works and metallurgical plants include papers on the place of emission spectrum analysis in the metal industry, on structural changes in soft steel during annealing, and on the accurate measurement of the temperature of boiler flue gases with suction pyrometers.

MITTEILUNGEN DER DEUTSCHEN MATERIALPRÜFUNGSANSTALTEN. Sonderheft 17. J. Springer, Berlin, 1931. Paper, 8 × 12 in., 79 pp., illus., diagrams, charts, tables, 12 r.m.

This number contains reports of eleven researches upon the properties of various metals, carried out in German research laboratories. Among them are papers on the influence of tin upon the constitution of brasses, the influence of small amounts of other metals upon refined zinc, on the aging of steel, on magnesium and its alloys, and on the cold-working of duralumin.

MONOGRAPHS ON PHYSICAL SUBJECTS. E. P. Dutton & Co., New York, 1931. Cloth, 4 × 7 in., diagrams, charts, tables, $1.10 each. Commutator Motor, by F. J. Teago, 80 pp.; Photochemistry, by D. W. G. Style, 96 pp.; Thermodynamics, by A. W. Porter, 96 pp.

These concise little volumes, by men actively engaged in research work on the subjects about which they write, are intended to supply readers of average scientific attainments with compact statements of the modern position in each subject. They are admirably adapted to the needs of those not in contact with active scientific work or engaged on work in related sciences, who wish to become quickly conversant with the accepted principles in various fields.

PETROLEUM ENGINEERING HANDBOOK. Second edition. Palmer Publications, Inc., Los Angeles, Calif., 1931. Cloth, 9 × 12 in., 461 pp., illus., diagrams, charts, tables, $5.

The second edition of this handbook contains a collection of new papers upon recent technical developments in the industry, by various experienced men. Among the subjects treated are appraisal methods, cementing practice, evaporation, storage, fire protection, pipe lines, pumping, repressuring, and vapor-phase treatment. The catalog section supplies a guide to manufacturers of equipment.

PETROLEUM IN THE UNITED STATES AND POSSESSIONS. By R. Arnold and W. J. Kemnitzer. Harper Brothers, New York and London, 1931. Cloth, 6 × 10 in., 1052 pp., maps, charts, tables, $16.

An exhaustive, encyclopedic review of the history and development of petroleum production in this country. The geology, technology, and economics of each field are presented, and the situation in the non-productive states is also reviewed. An immense amount of statistical information is tabulated. Ample select bibliographies are included. The book will be indispensable to students of the oil industry.

PLASTICITY. By A. Nadai and A. M. Wahl. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 349 pp., illus., diagrams, charts, $5.

The need for a comprehensive treatise on plasticity written in the English language has long been felt by engineers and physicists. The present book meets this want very happily, by providing an authoritative account of the subject, with emphasis upon its applications to the problems of metal working, mechanical engineering, geology, and geophysics.

Although based upon the author's work "Die bildsame Zustand der Werkstoffe," so much additional material has been added that this is practically a new work.

PRINCIPLES OF KNITTING. By Max C. Miller. McGraw-Hill Book Co., Inc., New York, 1931. Cloth, 6 × 9 in., 234 pp., illus., diagrams, $4.

This book aims to give the principles involved in making knitted fabrics and to describe briefly the mechanisms used and the fabrics produced. Emphasis is placed upon hosiery, but fancy fabrics are also treated. Basis machine designs are illustrated quite fully and probable future developments are discussed. The material has previously appeared as articles in the *Textile World*.

PROJECTING SOUND PICTURES. By A. Nadell. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 265 pp., illus., diagrams, charts, $2.50.

A book for theater men interested in the reproduction of sound. The principles underlying the mechanisms and circuits used for that purpose are described in a simple, practical manner, and attention is given throughout to the more common troubles of sound apparatus and methods of preventing them.

RELATIVITY. By M. Palmieri. Forbush Publishing Co., Los Angeles, Calif., 1931. Cloth, 8 × 11 in., 87 pp.

A brief non-mathematical presentation of the theory of relativity, intended for lay readers who wish to understand its principles and consequences.

DIE SCHNELLDREHSTÄHLE. By W. Oertel and A. Grützner. Verlag Stahleisen, Düsseldorf, 1931. Cloth, 6 × 8 in., 223 pp., illus., diagrams, charts, tables, 12 r. m.

This monograph on the high-speed tool sheets discusses their constitution, preparation, working, heat treatment, physical properties, and performances. A chapter is devoted to cast tools and another to cutting alloys of the stellite and metallic carbide

types. The patents issued by the principal countries are catalogd, and much information on cutting speeds is tabulated. The book is a useful summary of the subject, of interest to makers and users of tool steel.

Scientific Approach to Labor Problems. By A. Ford. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 446 pp., illus., diagrams, charts, tables, $4.

The aim of this work is to furnish a simple description of the kinds of activities which make up the content of personnel research and measurement in the field of labor management. In the first part are described those materials of scientific management which may be understood without extensive training in biological statistics, while in the second the technique of mathematical approach is presented in simple terms. The applications of the laws of physiology and psychology to labor management are presented. Production ratings, training systems, selection methods, welfare service, and other such similar topics are discussed.

Second World Power Conference, Berlin, 1930. Transactions, Vol. 20, Index. V.D.I. Verlag, Berlin. Cloth, 6 × 10 in., $85 per set.

This volume completes the Transactions of this conference, held in Berlin, in June, 1930.

The Transactions contain the papers presented, numbering over three hundred and fifty. These are in twenty volumes of handy size, each containing papers upon related subjects, which may be purchased singly. These are fully indexed by author and subject in this final volume. The index is tri-lingual—English, German, and French.

Steam Power and Internal Combustion Engines. By D. P. Craig and H. J. Anderson. McGraw-Hill Book Co., New York, 1931. Cloth, 6 × 9 in., 482 pp., illus., diagrams, charts, tables, $4.

A clear, comprehensive presentation of the fundamental principles of heat-power machinery. Modern types of the essential machinery are described, the theory underlying its construction and operation is explained, and modern methods of adaptation to power units are discussed.

1931 Supplement to Book of A.S.T.M. Standards. Philadelphia, American Society for Testing Materials, 1931. Paper, 6 × 9 in., 144 pp., $1.50.

This supplement brings up to date the 1930 Book of Standards published by the Association. It contains thirty-two standards, seventeen of which are new and fifteen replacements of former ones. Among them are specifications for alloy-steel bolting material for high-temperature service; welded wrought-iron pipe; high-test gray-iron castings; aluminum-alloy sheets and castings; hydrated lime; structural clay tile; white and red lead; and bronze powders. Methods are given for testing concrete, brick, pigments, slate, insulating oils, and other materials.

Technical Writing. By T. A. Rickard. Third Edition. John Wiley & Sons, New York, 1931. Cloth, 5 × 8 in., 337 pp., $2.

Interest in correct speech has become much more widespread since Mr. Rickard's book first appeared in 1919, and many textbooks have appeared since that date. His work still remains, however, one of the most readable and best guides to the engineer who wishes to improve his power of expression. It may be recommended heartily. This new edition, prepared for the American Institute of Mining and Metallurgical Engineers, differs from the second edition only in sundry small corrections.

Theorie der Thermischen Messgeräte der Elektrotechnik, Grundlagen zu ihrer Berechnung. By J. Fischer. Ferdinand Enke, Verlag, Stuttgart, 1931. Paper, 7 × 10 in., 147 pp., diagrams, charts, tables, 13 r.m.

Presents in systematic form the theoretical principles underlying hot-wire instruments, thermo-couples, bolometers, and similar instruments, and summarizes the results of research upon the question of heat transfer. This knowledge is then used to discuss the theory of the various types of instruments. The book supplies the designer with the fundamental data of which he has need.

Tonfilm, Aufnahme und Wiedergabe nach dem Klangfilm-Verfahren. (System Klangfilm-Tobis.) By F. Fischer and H. Lichte. S. Hirzel, Leipzig, 1931. Paper, cloth, 7 × 10 in., 455 pp., illus., diagrams, charts, tables, paper, 26 r.m.; bound, 27.80 r.m.

A comprehensive treatise, by a number of specialists, upon the production and reproduction of sound films. The physical principles of the method are discussed at length, and the construction of the apparatus is described in detail. The book gives a careful, complete description of current European practice.

Union-Management Cooperation on the Railraods. By L. A. Wood. Yale University Press, New Haven, 1931. Cloth, 6 × 9 in., 326 pp., $4.

A study of actual conditions on railroads committed to union-management cooperation. By personal visits and interviews with railroad and union officers, the author has collected data and views which are presented comprehensively and impartially. The technique of cooperation, the results obtained, and the problems that arise are treated.

Untersuchung Über Nitrozelluloselacke mit Pigmenten. (Fachausschuss für Anstrichtechnik, No. 11.) By W. Toeldte. V.D.I. Verlag, Berlin, 1931. Paper, 9 × 12 in., 37 pp., illus., charts, diagrams, tables, 6.50 r.m.

Gives the results of tests of a series of 102 pigmented lacquers prepared by the author, and of nine commercial varieties. The tests were undertaken to determine their suitability as automobile finishes, and included their behavior when exposed to sand and dust streams, heat and cold, weather, periodic wetting, etc. The influence of the components upon loss of luster, cracking, flaking, etc., were also studied.

Versuche Äber die Spannungsverteilung im Zughaken. By K. Böttcher. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, No. 337. V.D.I. Verlag, Berlin, 1931. Paper, 8 × 12 in., 20 pp., illus., diagrams, charts, tables, 5 r.m.

Reports the results of a systematic inquiry into the entire problem of stress distribution in a hoisting hook, undertaken to ascertain the accuracy of the assumptions usually adopted in calculating the stresses in severely curved bars. The tests are described in detail, and the results are compared with those calculated by various usual theories. Conclusions of a theoretical and practical nature are drawn.

Wages. By M. E. Leeds and C. C. Balderston. University of Pennsylvania Press, Philadelphia, 1931. Cloth, 6 × 9 in., 75 pp., diagrams, charts, tables, $1.50.

This is a case study of wages in the Leeds & Northrup Co. from 1901 to 1929, and forms part of a more comprehensive investigation of wagesetting and promotion, now in progress. This study explores the relationship between the age and length of service of the worker and the size of his family; attempts to determine the health and decency requirements for each family size and checks the actual incomes of the workers against these bases. It thus endeavors to establish the minimum below which the wages of no properly placed worker should fall.

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AIR COMPRESSORS

Rotary. Turbo-compresseur de 10,000 kw. de la centrale de Rosherville, près de Johannesbourg (Transvaal) (10,000 Kw. Turbo-Compressor at Power Plant of Rosherville Near Johannesburg). Génie Civil, vol. 99, no. 8, Aug. 22, 1931, pp. 186–189, 7 figs. Design and performance data for compressor built by Brown-Boveri for delivering 132,000 cu. m. per hr. at pressure of 9.5 kg. per sq. cm. absolute; method of pressure regulation and cooling.

AIRPLANE ENGINES

Fiat. Fiat Works Producing Seven-Cylinder Air-Cooled Engine for Small Planes. Automotive Industries, vol. 65, no. 12, Sept. 19, 1931, pp. 428–429, 6 figs. Design and specifications of engine developing 120 hp. at 2000 r.p.m. with bore and stroke of 4.13 by 4.73 in.; compression ratio 5.5; weight 2.83 lb. per hp.

Rolls-Royce. The Rolls-Royce Racing Engines. Flight, vol. 23, no. 40, Oct. 2, 1931, pp. 989–994, 10 figs.; see also Aircraft Eng., vol. 3, no. 32, Oct. 1931, pp. 244–246, 11 figs. Development and design of Rolls-Royce water-cooled 12-cylinder vee type "R" engine used in Schneider contest; bore and stroke of 6 by 6.6 in.; developing 2300 b.hp. at 3200 r.p.m., and weighing 1630 lb.

AIRPLANES

Autogiros. See AUTOGIROS.

Passenger. Development of the High-Speed Burnelli Type Monoplane, F. Wertenson. Aero Digest, vol. 19, no. 3, Sept. 1931, pp. 48–50 and 120, 3 figs. Power breakdown indicates that wing horsepower required is 42 per cent of entire power; power economics of Burnelli and high-speed single design.

Propellers. Propeller Materials and Airplane Safety, L. D. Webb. Aviation Eng., vol. 4, no. 3, Mar. 1931, pp. 15–18 and 31–32, 4 figs. Fatigue limits in forged aluminum-alloy propeller of detachable-blade type; procedure for testing of propeller equipment; development of magnesium propeller; hollow steel propeller; centrifugal stresses.

The Effect of Small Angles of Yaw and Pitch on the Characteristics of Airplane Propellers, H. B. Freeman. Nat. Advisory Committee Aeronautics—Report no. 389, 1931, 11 pp., 11 figs. Tests of full-scale propeller and fuselage combination at four angles of yaw and of model propeller, nacelle, and wing combination at five angles of pitch; results show that effect on propeller performance is small.

Stability. Lift Distribution and Longitudinal Stability of an Airplane, C. Topfer. Nat. Advisory Committee Aeronautics—Tech. Memo., no. 641, Oct. 1931, 7 pp., 4 figs. Shortcoming of conventional method of calculating lift distribution and stability; comparison of gliding and power flight; attempt to eliminate errors in preliminary calculation by assumption of distribution of lift distribution; explanation of great differences found in flight with and without propeller slipstream.

Wing-Slotted. A Study of Slots, Rings & Boundary Layer Control by Blowing, H. C. H. Townend. Roy. Aeronautical Soc.—Jl., vol. 35, no. 248, Aug. 1931, pp. 711–743, 16 figs. Study of certain cases of airflow in which various means are employed to control behavior of air so as to prevent breakdown in flow and resulting turbulence; section used was R.A.F. 31; graphs illustrate velocity distribution. Bibliography.

Wings—Testing. Tests of N.A.C.A. Airfoils in the Variable-Density Wind Tunnel, E. N. Jacobs and R. M. Pinkerton. Nat. Advisory Committee Aeronautics—Tech. Notes, no. 392, Sept. 1931, 30 pp., 11 figs. on supp. plates. 45 series, has maximum mean camber of 4 per cent of chord at position 0.5 of chord behind loading edge; 65 series, has maximum mean camber of 6 per cent of chord at same position; maximum thickness-chord ratios being: 0.06, 0.09, 0.12, 0.15, 0.18, and 0.21.

AIRSHIPS

Military. Le dernier dirigeable Francais la vedette "Zodiac Vz. 27" (Recent French Dirigibla Scout Zodiac VZ. 27), M. Verneuil. Genie Civil, vol. 99, no. 5, Aug. 1, 1931, pp. 105–109, 10 figs. Design, performance data and aerodynamic characteristics of 3410 cu. meter airship of semi-rigid type; two engines developing 120 hp. at 1800 r.p.m. each, provide speed of over 100 km. per hr.

The Largest Dirigible. Aviation, vol. 30, no. 10, Oct. 1931, pp. 599–600, 2 figs. U.S.S. Akron's design and construction; nominal gas volume 6,500,000 cu. ft.; length o.a. 785 ft.; gross lift 403,000 lb.; useful lift 182,000 lb.; total horsepower 4480, range 9200 mi.

Propulsion—Gears. Triebwerkanlage mit Vorgelege im Luftschiff "Graf Zeppelin" (Propulsion Gear Installation in Airship Graf Zeppelin), F. Sturm and M. Schirmer. V.D.I. Zeit., vol. 75, no. 28, Sept. 19, 1931, pp. 1189–1192, 9 figs. Layout, operating principles, and test results at different speeds obtained with Maybach engine equipped with reduction gear built by Zahnradfabrik Friedrichshafen.

ALLOYS

Aluminum. See ALUMINUM ALLOYS.

Heat-Resisting. Engineering Requirements for Heat Resisting Metals—II, J. C. Woodson. Heat Treating and Forging, vol. 17, no. 8, Aug. 1931, pp. 796–799, 4 figs. Composition of alloys used for cast carburizing containers; high sodium content of carburizing compound harmful; experiences with pot furnaces, Class II (a); high temperatue furnaces, class III. Before Am. Soc. Mech. Engrs. and Am. Soc. Testing Matls.

Lead. See LEAD ALLOYS.

ALUMINUM ALLOYS

Corrosion-Resisting. A New Aluminum Alloy. Automobile Engr., vol. 21, no. 284, Sept. 1931, p. 356, 2 figs. Physical properties of corrosion-resisting aluminum alloy called "Birmabright," introduced by Birmingham Aluminum Casting.

AUTOGIROS

Stability—Starting. Development in Stability and Rotor Starting Characteristics of the Autogiro, R. H. McClarren. Aviation Eng., vol. 4, no. 4, Apr. 1931, pp. 20–22 and 33, 9 figs. Pendular stability; vertical articulation and its correct use; lateral stability; problem of starting.

AUTOMOBILE ENGINES

Cooling Systems. Wassersteinloesungsmittel fuer Kuehlanlagen von Fahrzeugmotoren (Scale Dissolving Preparation for Cooling System of Automobile Engine), W. Zumpe. V.D.I. Zeit., vol. 75, no. 28, Sept. 19, 1931, pp. 1193–1196, 8 figs. Effect of scale in radiator and cylinder jackets; investigation of efficiency of dissolving preparations on buses of Berliner Verkehrs A.G.; effect of cleaning on output, fuel consumption, exhaust gas composition and cooling; dynamometer and road test results.

Diesel. See DIESEL ENGINES, Automotive.

Fuel Consumption. Zur. Kurzstreckenmessung des Brennstoffverbrauches im Bewegten Fahrzeug (Short-Distance Measurement of Fuel Consumption in Moving Vehicles), H. Straubel. Automobiltechnische Zeit., vol. 34, no. 23–24, Aug. 20–31, 1931, pp. 519–525, 7 figs. Testing methods and equipment developed at Technischen University of Breslau; photographic recording of fuel consumption over time interval of 1/100 sec.; road-test data relating to fuel consumption during acceleration.

AUTOMOBILES

Axles—Heat Treatment. Heat Treating Tubular Axles, I. W. Sprink. Heat Treating and Forging, vol. 17, no. 8, Aug. 1931, pp. 791–793, 4 figs. Production methods and equipment of Logan Gear Co., with particular regard to operations of normalizing and hardening furnace, and quenching machine; at production rate of 75 axles (1200 lb. net work) gas consumption of drawing furnace is approximately 669 cu. ft. of gas per hr.

Design. La construction automobile en 1932 (Automobile Design in 1932), Mortimer-Mégret. Pratique Automobile, vol. 27, no. 592, Oct. 1, 1931, pp. 16771–16773, 8 pp. between 16776–16790 and 7 pp. between 16846–16858, 31 figs.

New features of 1932 models with particular regard to French makes; improvements in body design.

Fiat. La 14 CV Fiat Type 522 (14 Hp. Fiat Type 522), R. Charles-Faroux. Vie Automobile, vol. 27, no. 973, July 10, 1931, pp. 249–251, 6 figs. Design of 6-cylinder car with engine of 72 by 103 mm. bore and stroke; wheelbase 3.07 m.; hydraulic brake and Silentbloc shackles.

Manufacture—Great Britain. Ford Production Methods. Machy. (Lond.), vol. 38, no. 987, Sept. 10, 1931, pp. 749–759, 24 figs. Production methods and equipment at Trafford Park plant; continuous operations on cylinder block; combined operations; machining operations on pistons; gear-tooth chamfering by notching process; flywheel balancing.

Machining Operations on Clutch Parts, Connecting Rods, and Stub Axles. Machy. (Lond.), vol. 38, no. 988, Sept. 17, 1931, pp. 785–790, 14 figs. Drilling and reaming drop-forged clutch and brake pedals at rate of 70 per hr.; operations on hydraulic broaching machine with broach dropping and indexing gear for slotting clutch plates; pneumatic hammering equipment for bedding white metal into main bearings; centerless grinding machine equipped for grinding two diameters on stub axles; duplex head screwing machine as used for threading spring brackets, stub axles and transmission shafts.

Universal Joints. Das Flexia-Kardangelenk (Flexia Universal Joint), Lesser. Deutsche Motor-Zeit., vol. 8, Feb. 26, 1931, pp. 90 and 92, 4 figs. Advantages of universal joint consisting of wire-rope arrangement; particularly suitable for high torque and not requiring lubrication.

Weiss Designs Universal Joints With Variable Radii Grooves. Automotive Industries, vol. 65, no. 12, Sept. 19, 1931, p. 438, 2 figs. Weiss uniform-transmission universal joint with rollers between driving and driven member for increased wear resistance; ball grooves of variable radii, to reduce wear when operating at small angles.

B

BOILER FEEDWATER

Treatment. Eliminating Trouble Through Water Treatment. Power, vol. 74, no. 8, Aug. 25, 1931, pp. 272–274, 3 figs. Some of most difficult problems of plant center around treatment of water, particularly chemical treatment of raw feedwater and conditioning of boiler water; hot-process softeners; zeolite softeners; blowdown easily determined; embrittlement of boilers; A.S.M.E. Code requirements.

BOILERS

Control, Automatic. Die halbselbsttaetige Kesselsteuerung im Kraftwerk Issy-les-Moulineaux (Semi-automatic Boiler Control System in Issy-les-Moulineaux), O. Graef and J. Moeller. Elektrotechnische Zeit., vol. 52, no. 36, Sept. 3, 1931, pp. 1145–1147, 4 figs. Novel control system by which individual boiler motors are connected to changeable voltage; control of each boiler is done by controller similar to type used in traction; all boiler regulators may be operated simultaneously in such manner that entire boiler house can be controlled by two push buttons.

Design. Developments in High Steam Pressures and Temperatures, D. S. Jacobus. West. Soc. Engrs.—Jl., vol. 36, no. 4, Aug. 1931, pp. 227–248 and (discussion) 248–252, 23 figs. Historical review of past seven years' development of boilers; pressures have nearly doubled, temperatures have been increased, and efficiency improved until now these large installations regularly convert 85 per cent or more of heat energy in coal into steam.

Efficiency Calculation. Kesseleistungen im unbauten Raum (Calculation of Boiler Performance According to Space Occupied), W. Tichy. Waerme, vol. 54, no. 36, Sept. 5, 1931, pp. 661–667, 13 figs. As departure from practice of measuring boiler efficiency according to width, suggestion is made to base measurements on space required for boiler graph; details of improved arrangement with type of two-drum boiler; it is claimed system results in considerable saving of space.

Firing. Stand u. Entwicklungsziele der modernen Steinkohlenfeuerungstechnik (Status and Aims of Modern Bituminous Coal-Firing Technology), W. Kretschmer. Internationale Bergwirtschaft und Bergtechnik, vol. 24, nos. 13, 14 and Aug. 15, 1931, pp. 169–172, Sept. 15, pp. 192–196, 11 figs. Ignition and combustion phenomena of coal; requirements of ideal furnace; different types of furnaces and stokers for burning bituminous coal.

Furnaces, Water-Cooled. Water-Cooled Furnaces, P. N. Oberholtzer. Power Plant Eng., vol. 35, no. 7, Sept. 1, 1931, pp. 890–891, 3 figs. Design and performance, especially for underfeed stokers; use of lining blocks; operating experiences.

High-Pressure. Natural Circulation of Water in Sulzer Super High-Pressure Boilers. Sulzer Tech. Rev., no. 3, 1931, pp. 13–18, 6 figs. Diagrammatic representation of circulation in down tubes when inlet velocity of water is less than relative velocity of water and steam bubbles; Sulzer method clears up certain points which have hitherto been obscure with respect to down tubes; curves of density of mixture of steam and water, of volumetric percentage of water, of loss of pressure, within tube, etc.; various other curves are given.

Operation of High-Pressure Boilers, W. F. Ryan. Power, vol. 74, no. 8, Aug. 25, 1931, pp. 261–263, 3 figs. Speeding up of equipment in modern boiler plants has resulted in speeding up operator as well; elimination of scale brings new problems; temperature stress and creep; false water levels in high-pressure boilers.

The Benson and Atmos Boilers. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 341–342, 3 figs. Review of two papers before International Congress of General Mechanics; one, by L. Herry, dealt with Benson boiler and gave particulars of large unit put into commission at Langerbrugge power station; M. M. Ehlinger described progress attained in design of Atmos boiler.

Locomotive—Efficiency. On the Boiler Efficiency of Steam Locomotives—I, K. Okamoto. Japanese Gov. Rys.—Bul., vol. 19, no. 32, Aug. 25, 1931, 118 pp., 112 figs. Based upon results of test made on superheated steam locomotives, No. 28666, C 51179, C 522, and C 5318, study has been carried out on relation between boiler efficiency and rate of combustion from viewpoint of combustion and thermal conduction; result of investigations expected to be of value for determination of evaporative power of boiler and for calculation of tractive force of steam locomotives. Brief English Abstract.

Operation. Elastizitaet von Dampfkesselfeuerungen (Elasticity of Boiler Furnaces), E. Praetorius. Elektrizitaetswirtschaft, vol. 30, no. 17, Aug. 1931, pp. 500–504, 9 figs. Various starting periods; starting from cold conditions after interruptions in operation and from no-load; control tests; elasticity constants for load increase and load decrease; starting losses; decreasing starting losses. Bibliography.

Electric Steam Boiler Performances Compared, N. D. Paine. Elec. World, vol. 98, no. 11, Sept. 12, 1931, pp. 472–473. Comparative table as reported by author at recent annual meeting of electrical apparatus committee, Canadian Electrical Association.

Plates—Cracking. Ermittlung der Ursachen eines Risses zwischen den Rohrloechern eines Steilrohrkessels (Determination of Causes of Cracks Between Tube Holes of Vertical-Tube Boiler), Schumacker. Waerme, vol. 54, no. 37, Sept. 12, 1931, pp. 689–693, 13 figs. Results of investigation showed that failure was due to imperfect design in manufacture of boilers.

Risse in Rundnaehten von wassergasgeschweissten Trommeln (Cracks in Circumferential Seams of Water-Gas Welded Drums), Herms. Waerme, vol. 54, no. 37, Sept. 12, 1931, pp. 682–688, 22 figs. Investigation of cracks observed in joints of four vertical-tube boilers 3 months after they were put in operation; method of testing and repair.

Tubes. Bemessung von Siederohren fuer Hochleistungskessel (Dimension of Boiler Tubes for High-Capacity Boilers), E. Lupberger. Archiv fuer Waermewirtschaft, vol. 12, no. 9, Sept. 1931, pp. 267–269, 7 figs. Significance of heat stresses in boiler tubes; exact determination of heat distribution is not necessary as only average heat load need be expected; new German regulations for calculation and materials specifications are considered advantageous.

The Hardness of a Steel Tube Along Certain "Lueders" or "Piobert" Line, H. Fowler. Engineering, vol. 132, no. 3425, Sept. 4, 1931, p. 299, 3 figs. Investigation of locomotive-boiler tubes which were rusting in manner which suggested presence of "Lueders" lines; rusting had only taken place along lines where mill scale had cracked; investigation showed that this cracking of scale could be reproduced in carefully made tensile test; in manufacture, tubes are often straightened after becoming bent during annealing, and this was undoubtedly cause of scale cracking and subsequent rusting of tubes which first drew attention to matter. Before Brit. Assn.

Water-Level Indicators. The K.B.B.-Lumsdaine Liquid-Level Gauge. Engineering, vol. 132, no. 3425, Sept. 4, 1931, p. 279, 3 figs. Kelvin, Bottomley, and Baird (Glasgow) gage making use of positive motion of solid float, movement of which is communicated to outside of vessel without introduction of glands or other hindrances to accuracy.

C

CARS

Bearings—Lubrication. The Isothermos Axlebox. Ry. Gaz., vol. 55, no. 12, Sept. 18, 1931, pp. 368–369, 3 figs. Practical application of principle of film lubrication to railway rolling stock; graph showing flow of oil in typical "isothermos" axlebox at varying speeds; design and constructional features of "isothermos" axlebox; outstanding advantages.

Passenger—Air Conditioning. Air Conditioning With Water as a Refrigerant. Ry. Age, vol. 91, no. 11, Sept. 12, 1931, pp. 398–400, 6 figs. Air-conditioning system for railroad passenger cars which employs nothing but water and steam as means of refrigeration has been developed by Carrier Engineering Corp., Newark, N. Y.; steam from train line supplies most of power required; electric motors are used for fans and circulating pumps; temperature control; test performance; heating system for winter.

CASE-HARDENING

Carburizing. Effect of Surface Decarburization on Fatigue Properties of Steel, C. R. Austin. Metals and Alloys, vol. 2, no. 3, Sept. 1931, pp. 117–119, 6 figs. Summary of research work relating to nature of surface and propensity of underlying material to allow crack to propagate or to stop its advance; effect of slight surface decarburization upon endurance limit.

CAST IRON

Properties. Structure and Mechanical Properties of Cast Iron, J. G. Pearce. Int. Congress Testing Matls.—Advance Paper, 1931, 8 pp., 9 figs. Ordinary cupola-melted cast irons of similar chemical composition may have widely differing mechanical properties, due to differences in conditions of melting; these conditions affect size and distribution of graphite; mechanical properties of gray cast iron vary continuously with diameter of specimen tested, and with silicon content, for constant melting conditions; advantages of superheating may be secured without danger of production of ferrite.

Wear. The Wear and Surface Condition of Cast Iron, T. Klingenstein. Metallurgist (Supp. to Engineer), Sept. 1931, pp. 132–134, 2 figs. Review of work on wear testing of cast iron published in report of Research Department of Gutehoffnungshuette Konzern; minimum wear is obtained when moving and stationary test pieces are of same Brinell hardness, becoming less as pearlitic condition is reached; machining processes tend either to surface destruction, such as by slow turning or grinding, or to surface preservation, such as by high-speed turning or lapping.

CHROMIUM STEEL

Working. Working With High-Chrome Steels, C. B. Lord. Am. Mach., vol. 75, no. 12, Sept. 17, 1931, pp. 455–458, 3 figs. Machining, press-working, forging, casting welding illustrated by examples.

CHROMIUM-NICKEL STEEL

Welding. Riveting or Welding Rustless Steel Structures, T. H. Nelson. Iron Age, vol. 128, no. 15, Oct. 8, 1931, pp. 934–937 and 983, 5 figs. Air-hardening tendencies have made satisfactory welding of lower chromium alloys difficult; higher-chromium alloys are non-hardening; welding done most successfully with chromium-nickel steels of 18 and 8 type; failures are due to reliance on small test pieces as examples; special atmospheres and coated welding rods.

Welding the 18–8 Alloys, G. van Dyke. Welding Engr., vol. 16, no. 7, July 1931, pp. 29–30, 2 figs. Consideration in gas welding Allegheny metal; proper mixture of acetylene and oxygen; electric welding by metallic arc process; reversed polarity should be used.

COAL

Calorific Value. Rechentafel fuer die Berechnung des Heizwertes fester Brennstoffe (Table for Calculation of Calorific Value of Solid Fuels), W. Zwieg. Chemiker-Zeitung, vol. 55, no. 75, Sept. 19, 1931, p. 723. Method developed by author makes use of numerical table of established calorific values.

Liquefaction. Cost in the Production of Liquid Fuel From Coal, A. S. Fitzpatrick. Chem.

Eng. and Min. Rev., vol. 23, no. 275, Aug. 5, 1931, pp. 420–428, 1 fig. Economics of methods of producing liquid fuel from coal; review of processes for liquid fuel production; coal carbonization; disposal of carbonization products; hydrogenation and synthesis of fuels; yields; Australian conditions.

COMBUSTION

Automatic Control. Simplified Automatic Combustion Control at Powerton Station. Power, vol. 74, no. 9, Sept. 1, 1931, pp. 314–317, 10 figs. Three pilot-motor-operated field rheostates make all necessary adjustments in fan and fuel feeder speeds on each boiler to regulate for steam demand; secondary adjustments of one or more of same rheostats by individual boiler controls maintain proper furnace pressure and proper ratio of air to fuel; wiring diagram of simplified system of Rossman-Bailey automatic combustion control; diagrammatic drawing illustrating application of automatic control equipment.

CONVEYORS

Coal-Handling. The Selection of Conveyor Belts for Coke and Coal Handling, E. J. Tournier. Gas Age-Rec., vol. 68, no. 11, Sept. 12, 1931, pp. 367–369, 2 figs. Factors affecting service rendered by belts; formulas for determining ply thickness and for determining tonnage belt will carry.

Speed Reducers. Applying Gear Speed Reducers to the Driving of Conveyors, J. S. Howard. Indus. Transmission and Conveying, vol. 39, no. 3, Sept. 1931, pp. 5–6 and 20–21, 4 figs. Space limitations and operating conditions often produce exacting problems in conveyor drives, which can be met by selection of proper gear-speed reducer; types of reducers; load factors; standardizing equipment.

CRANES

Aluminum. Light Aluminum for Overhead Traveling Cranes, R. L. Templin. Eng. News-Rec., vol. 107, no. 15, Oct. 8, 1931, pp. 574–576, 3 figs. Practice of United States Aluminum Co.; design, manufacture, service characteristics, and probable trends; experience indicates truss type holds advantages over box-girder design; list of aluminum cranes in service July, 1931; comparative weights of 10-ton truss-crane parts in aluminum and steel; load-deflection curve for aluminum truss-type crane.

CRANKSHAFTS

Vibrations. Schwingungsdaempfer fuer Kurbelwellen (Vibration Dampers for Crankshafts), O. Foeppl. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 4, Apr. 1931, pp. 124–128, 7 figs. Effect of damper on shaft; calculation of best damping coefficient for friction damper; application of results to rubber damper.

CYLINDERS

Design. Over een verzwakking ontstaan door het aanbrengen van ruggen (Decrease in Strength Resulting From Ribs), C. B. Bienzeno. Ingenieur, vol. 46, no. 36, Sept. 4, 1931, pp. W133–W137, 8 figs. With aid of approximate calculation, it is shown that ribs on cylinder cover, with packing bushing casing cast on it, have tendency to weaken this machine part.

D

DIES

Punching. Punching and Forming in the Strip, C. F. Smith. Am. Mach., vol. 75, no. 14, Oct. 1, 1931, pp. 522–523, 7 figs. Design and operation of dies and fixtures; method of feeding sheet or strip material.

Stamping. Close Accuracy Maintained in Making Large 855-Hole Piercing Die. Iron Age, vol. 128, no. 15, Oct. 8, 1931, pp. 941–943 and 983, 5 figs. Stamping 36 in. long, $13^1/_8$ in. wide and $^1/_8$ in. thick and has 855 holes; used in voting machine, it is held to accuracy of 0.002 in. between extreme holes; complete die and gage required laying out and finishing of 3420 holes; operation of Pratt & Whitney jig bore, capable of originating, duplicating, and checking its own measurements to 0.0001 in.

The Construction and Uses of Typical Dies—II, III, IV, V, VI, and VII, E. Heller. Metal Stampings, vol. 4, nos. 2, 3, 4, 5, 6, and 7, Feb. 1931, pp. 153–154 and 166, Mar., pp. 233–234 and 242, Apr., pp. 341–342 and 350, May, pp. 431–432, June, pp. 503–504 and 512, and July, pp. 591–592, 23 figs. Feb.: Blanking and piercing dies. Mar.: Cutting and forming dies. Apr.: Special blanking dies. May: Inverted drawing dies. June: Power brake tools. July: Offset and grooving dies employed in press brake.

DIESEL-ELECTRIC POWER PLANTS

Costs. Costs at Grand Haven Diesel Plant, C. A. Hamilton. Power, vol. 74, no. 12, Sept. 22, 1931, pp. 418–421, 2 figs. Detailed construction and investment costs on 1600-kw. municipal plant completed this year to replace obsolete steam plant; present operating cost, exclusive of fixed charges, 7.36 mills per kw-hr.; electrical equipment; lubricating-oil system; building heating requirements.

DIESEL ENGINES

Automotive. Der Fahrzeugdieselmotor (Automotive Diesel Engines), O. Holfelder. V.D.I. Zeit., vol. 75, no. 36, Sept. 5, 1931, pp. 1123–1126, 14 figs. Latest improvements and performance data on outstanding German makes together with review of research work according to papers presented before V.D.I., June 27, 1931, in Cologne.

Les moteurs a huile lourde et les automobiles (Heavy Oil Engines and the Automobile), E. Marcotte. Revue Industrielle, vol. 61, no. 2266, Sept. 1931, pp. 518–524, 6 figs. Design and performance characteristics of representative makes including Saurer, Morton; methods of using heavy oil in connection with spark ignition, with particular regard to systems Deutz, Maybach, Bellem, Rochefort, and Chilowsky.

M.A.N. Automotive Diesel Cuts Out Three Cylinders for Idling. Automotive Industries, vol. 65, no. 13, Sept. 26, 1931, pp. 459 and 487, 3 figs. Air-chamber 6-cylinder Diesel engine at 1500 r.p.m. (750 cu. in. displacement) develops 90 hp.; b.m.e.p. of 63.7 lb. per sq. in.; bore and stroke 4.73 by 7.09 in.

Neuere Fahrzeugdieselmotoren (Recent Automotive Diesel Engines), A. E. Thiemann. Automobiltechnischen Zeit., vol. 34, nos. 18 and 20–21, June 30, 1931, pp. 434–436, and July 20–31, pp. 478–479, 12 figs. Design and performance of new combustion chambers of Oberhaeusli-Dieselmotor, Sueddeutche Bremsen A.-G., Muenchen, Acro-Saurer, Bohn & Kaehler, and Lanz-Bulldogg engines.

The Latest Fowler Oil Engine. Commercial Motor, vol. 54, no. 1383, Sept. 15, 1931, p. 139, 3 figs. Four cylindered engine develops 50 b.hp. at 1400 r.p.m. and weighs, complete with flywheel, 28 lb. per b.hp.; six-cylindered engine develops 90 b.hp. at 1500 r.p.m. and weighs 23 lb. per b.hp.; bore and stroke $4^1/_4$ in. by 7 in.; piston with cavity to provide chamber to prolong combustion period.

Marine. The New Double-Acting Sulzer Two-Cycle Diesel Engine. Sulzer Tech. Rev., no. 3, 1931, pp. 1–6, 12 figs. Latest type of double-acting Sulzer engine, 7600-b.hp. marine engine built for Dutch cargo boat "Tajandoen," is described; some design details and continuous indicator diagrams of 25 to 106 r.p.m. are given.

DRILLS

Twist. Twist Drills Proving Their Quality. Metal Progress, vol. 20, no. 4, Oct. 1931, pp. 48–53, 5 figs. Testing methods and equipment used by Morse Twist Drill & Machine Co., New Bedford, Mass.; torque depth curves for 1 in. drills working respectively in aluminum, cast iron, machine steel, and alloy steel.

E

ELECTRIC FURNACES

Annealing. Annealing and Cleaning Strip Steel for Cold-Rolling. Iron Age, vol. 128, no. 16, Oct. 15, 1931, pp. 1000–1003, 4 figs. Layout and operation of electric furnaces at Cuyahoga works of American Steel & Wire Co.; 24 bell-type furnaces of 90 to 100-kw. capacity each; operated on three-phase, 220-volt, 60-cycle current; artificial atmosphere; continuous cleaner with various new features in connection with take-up frame.

ELECTRIC MANUFACTURING PLANTS

Switzerland. The Works of Brown, Boveri & Co., Ltd., Baden. Metal Industry (Lond.), vol. 39, no. 14, Oct. 2, pp. 327–328, 1 fig. Works consist of dynamo and motor shops, steam-turbine department and switchgear factory; power at disposal of works amounts to 7000 kw., of which 4000 are for running works and 3000 for test purposes and can be supplemented in special cases by further 5000 kw. by firm's own power plant.

ELECTRIC WELDING, ARC

Atomic-Hydrogen. Hydrogen Welding Now Automatically Controllable, S. Martin, Jr. Elec. World, vol. 98, no. 13, Sept. 26, 1931, p. 561, 1 fig. Welding automatically with atomic hydrogen flame presents problem of maintaining definite size of flame in fixed plane between two slowly consuming tungsten electrodes; relation of fringe of flame and work is fixed mechanically; push-button control scheme for automatic hydrogen welding, is given.

ELEVATORS

Electric—Operation. Elevator Operation in Modern Buildings. Power, vol. 74, no. 8, Aug. 25, 1931, pp. 285–286, 3 figs. Elevator operation in large building offers many opportunities for power savings, reducing maintenance costs, increasing reliability and improving service to building tenants.

Electric—Signal Systems. Pre-Register Signal System Stops Elevators Automatically. Power, vol. 74, no. 11, Sept. 15, 1931, pp. 391–393, 5 figs. System in which signals to stop are registered in advance by buttons in car and from landings; at proper point in car's travel operator notified by signal to center car switch so that car will stop automatically at landing for which signal was given; equipment design and operation.

Office Buildings. Planning Elevators for Special Service, C. F. Scott. Eng. News-Rec., vol. 107, no. 15, Oct. 8, 1931, pp. 569–571, 6 figs. Description of vertical transportation system of new McGraw-Hill building in New York; nine passenger cars are all 3500 lb. capacity, in size 7 ft. 4 in. by 6 ft. 4 in., with openings 3 ft. 8 in. wide; high rise cars, running at 800 ft. per min., are equipped with automatic control; low-rise passenger cars, running at 600 ft. per min., are equipped for manual operation, with automatic leveling; smooth operation is obtained through perfected control and extra heavy guide rails; details of pliotron floor-leveling mechanism.

ENGINEERING RESEARCH

Laboratories—Germany. Erweiterung der Maschinenlaboratoriums der Technischen Hochschule zu Breslau (Enlargement of Engine Laboratory at Technical University of Breslau), H. Baeand H. Faltin. V.D.I. Zeit., vol. 75, no. 35, Aug. 29, 1931, pp. 1097–1101, 15 figs. Planning of new power-plant extension with particular regard to installation of boilers, steam turbines, and Diesel engines in engine laboratory which also supplies energy and heat for other building of University.

Laboratories—Great Britain. The National Physical Laboratory. Engineering, vol. 132, nos. 3423, 3424, 3425, 3427, and 3428, Aug. 21, 1931, pp. 224–225, Aug. 28, pp. 261–263, Sept. 4, pp. 289–291, Sept. 18, pp. 352–354, Sept. 25, pp. 413–415, 18 figs. Aug. 21: Metallurgy department. Aug. 28: Physics department. Sept. 4: Metrology department. Sept. 18: Electricity department. Sept. 25: Transmission and receiving antennas; directional wireless; ultra-short waves; light and lighting.

F

FANS

Induced-Draft. The Howden Turbovane Induced-Draught Fan. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 307–309, 11 figs. partly on p. 316. B. F. Sturtevant Co., of Boston, have developed type of fan in which variable-inlet vanes are employed to control output, and these fans have been installed with satisfactory results at number of important power stations in United States; arrangements have been made for these fans to be constructed in England by J. Howden and Co.

Performance Characteristics. Fan Performance Characteristics, V. C. George and L. M. K. Boelter. Motive Power, vol. 2, no. 9, Sept. 1931, pp. 11–16, 15 figs. Object of wind-tunnel tests on cooling fans for internal-combustion engines conducted at University of California was to determine effects of speed, blade angle, number of blades, and net horsepower input as function of quantity of air pumped; performance curves of various fans; summary of test results.

FITS AND TOLERANCES

Hole Tolerances. Hole Tolerances and Tool Manufacture, J. Gaillard. Am. Mach., vol. 75, no. 15, Oct. 8, 1931, pp. 559–561, 2 figs. Successful introduction of cylindrical fits in German industry; reasons for lack of uniformity in United States; German tolerances on basic holes, reamer sizes, and gage ring bores.

Liquid-Air Fits. Expansion Fits With Liquid Air, E. V. David and W. S. Farr. Power, vol. 74, no. 14, Oct. 6, 1931, pp. 506–507. Review of new industrial use of liquid air for making and breaking expansion fits; composition of liquid air;

quantity of liquid air required; expansion-fit allowances.

Tolerance Determination. Rights and Wrongs of Dimensionings, F. W. Shaw. Am. Mach., vol. 75, no. 13, Sept. 24, 1931, pp. 489–490, 1 fig. Example illustrates principles of determining tolerances to insure desired fit and to accord with production and gaging methods.

FLOW OF FLUIDS

Boundary-Layer Theory. Versuche ueber die Grenzschicht-Bewegung auf rotierenden Scheiben (Tests of Boundary-Layer Movement on Rotating Disks), F. Busmann. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 9, Sept. 1931, pp. 335–339, 9 figs. Von Karman theory on movement of fluids in turbulent boundary layer on rotating disks; examination of theoretical results for rotating disks based on new method; application to investigation of flow in ship and turbine propellers.

FORGINGS, STEEL

Defects. Defects in Large Forgings, G. A. Smart. Heat Treating and Forging, vol. 17, nos. 8 and 9, Aug. 1931, pp. 759–762, and 775, and Sept., pp. 872–875, 14 figs. Aug.: Causes of defects and importance of eliminating them; study of pipe in ingots; red shortness and its effects. Sept.: Ghostlines owing to "crystal-line junctures," and heating defects; formula for proper time of heating.

Heat Treatment. Heat Treatment for Large Forgings, W. J. Merten. Heat Treating and Forging, vol. 17, no. 9, Sept. 1931, pp. 870–871, and 875, 2 figs. Methods of annealing and quenching for forging; microstructure of forging at different stages of manufacture.

Manufacture and Testing. Manufacture and Testing of Forging Quality Steels, N. L. Deuble. Heat Treating and Forging, vol. 17, no. 9, Sept. 1931, pp. 864–869, 6 figs. Manufacture of, and methods for testing, forging steels; problems of crack, segregation, and other uniformities in steel ingots; procedure in making macro etch test.

G

GAGES

Screw-Thread. The Measurement of External Screw Threads, F. Wende. Machy. (Lond.), vol. 38, no. 989, Sept. 24, 1931, pp. 821–823, 6 figs. Recent development in caliper-type gages; examples of faulty threads; snap thread gage with measuring edges at front faces of anvils; snap thread gage with fixed measuring rolls; new type of gage developed by precision tool division of F. Werner, A.G., Berlin, has flat anvils with parallel measuring surfaces, screw threads, as measured in direction of screw axis, having correct angle of thread and being cut in exact direction of average pitch angle.

GAS ENGINES

Valve Setting. Setting Valves of Large Gas Engines, R. C. Laney. Power, vol. 74, no. 14, Oct. 6, 1931, pp. 490–492, 3 figs. Practical discussion of valve setting operations in horizontal twin tandem double-acting types of blast-furnace gas engine; illustrations of indicating cards; valve design characteristics.

GAS TURBINES

Bertin. Turbo-Machine Système, G. Bertin (Turbo Machine System, G. Bertin). Genie Civil, vol. 99, no. 5, Aug. 1, 1931, pp. 117–118, 6 figs. Design and operating principles of experimental turbine utilizing not so much kinetic energy but expansion of gas.

GEARS

Design. Designing Gears to Minimize Wear, A. Schlag. Machy. (Lond.), vol. 38, no. 989, Sept. 24, 1931, pp. 827–831, 7 figs. Factors determining rate of wear; proportions of addendum and dedendum of tooth to satisfy conditions of minimum play; force of contact; coefficient of wear; graph for determining wear of mating gears.

Efficiency. The Efficiency of Spur and Helical Gearing, W. A. Tuplin. Machy. (Lond.), vol. 38, no. 986, Sept. 3, 1931, pp. 736–739, 3 figs. Loss due to oil bath resistance; turbulence of lubricating oil; example showing application on formulas.

Tooth Measurement. Checking Involute Tooth Forms by Block Gauging, F. W. Shaw. Machy. (Lond.), vol. 38, no. 988, Sept. 17, 1931, p. 797, 1 fig. Formulas for determining maximum number of teeth block may have for gear of any number of teeth; three popular tooth systems tabulated with corresponding formulas.

H

HARDNESS TESTING

Brinell. A Contribution to Brinell Ball Hardness Tests, M. Ichihara. Tohoku Imperial Univ.—Technology Report, vol. 10, no. 1, 1931, pp. 25–41, 16 figs. Experiment to measure how metallic surfaces are deformed when Brinell ball is impressed in them; cross-sectional curves of indentations were measured optically; empirical formula is given, applicable with error less than 0.002 mm. in regard to all observed metals.

HEAT EXCHANGERS

Design. Betrachtungen zu den Berechnungen von Waermeaustausch-, insbesondere Gegenstromapparaten (Calculation of Heat Exchangers With Particular Regard to Counter-Flow Type), F. Filchner. Gesundheits-Ingenieur, vol. 54, no. 27, July 4, 1931, pp. 417–420, 10 figs. Thermodynamic calculation in design of heat exchangers for heating of water by water, and heating of water by steam; graph illustrates relations between tube diameter, heating surface, number, length, and area of tubes; flow velocity and heat-transmission coefficients.

HEAT PUMPS

Batch Heating With. Batch Heating With a Varying Performance Heat Pump, J. C. Stobie. Instn. Engrs. Australia—Jl., vol. 3, no. 8, Aug. 1931, pp. 279–283, 10 figs. Possibility of heating water economically by reversed refrigeration cycle; theory of action and some experiments with small plant.

HEAT TRANSMISSION

Fins. Die Berechnung und Messung des Temperaturverlaufs in Waermeuebertragungsrippen (Calculation and Measurement of Temperature in Heat-Transfer Fins), C. Bogaerts and P. Meyer. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 7, July, 1931, pp. 237–244, 13 figs. Application of iteration process; calculation of temperature conditions with physical similitude; temperature curve with different fins; experimental investigation; significance of third dimension; best form of fin; circular fins.

HEAT TREATMENT

Vibrations and. The Influence of High-Frequency Vibrations Upon the Heat-Treatment of Materials, D. R. Lewis. Metallurgia, vol. 4, no. 22, Aug. 1931, pp. 126A–126B. Reduction in time, greater skin hardness, and enhanced general properties, are claimed to be obtainable for nitrogen-hardened materials under influence of high-frequency vibrations; objects of heat-treatment; nitrogen hardening; experimental results.

HOISTS

Self-Sustaining. Self-Sustaining Electric and Pneumatic Hoists. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 312–313, 7 figs. Hoists manufactured by Matterson, Ltd., are of particular interest owing to brake gear which is self-sustaining, without use of either pawl and rachet or electric brake; they may be either pneumatically or electrically operated.

HYDRAULIC TURBINES

Propeller. Propeller Turbines Gain Favor in Middle West, H. T. Porter. Power, vol. 74, no. 13, Sept. 29, 1931, pp. 449–452, 6 figs. Number of Kaplan installations show high efficiency over wide range of load and varying flow; increase in output ranging from 8 to 25 per cent lowers cost per kilowatt-hour over fixed-blade turbine, and installation of fewer units to use stream flow usually means lower initial investment; field tests made on turbines; operating records.

Water Turbines of the Propeller Type, L. F. Harza. Elec. Light and Power, vol. 9, no. 4, Apr. 1931, pp. 32–35, 6 figs. For past 50 years prior to about 1915 improvements consisted of slight changes in shape of blades and depth of runners of Francis type; after this in Europe and America radical departure was made from Francis type by introducing so-called "propeller" turbine; it is now built by all manufacturers with variations claimed to have some element of importance; design and characteristics are discussed in some detail.

Testing. I. E. C. Publication on the Testing of Hydraulic Turbines. Int. Electrotech. Commission—Pub., no. 41, 1931, 11 pp. Specification to provide standard directions for conducting and reporting performance test in way commonly undertaken in commercial work.

HYDRAULICS

Water Measurement. Problems of Water Measurement. Civil Eng. (N. Y.), vol. 1, no. 12, Sept. 1931, pp. 1095–1103, 12 figs. Symposium consisting of three articles: Models Predict Flow Through Structures, J. C. Stevens; Improving the Accuracy of Instruments, L. S. Hall; Unusual Flow Phenomena, F. C. Scobey; important features of knowledge concerning use of models for determining flow characteristics through hydraulic structures; importance of understanding limitations of models; errors in readings of rain gages.

HYDROELECTRIC POWER DEVELOPMENTS

Canada. The World's Largest—Saguenay's Chute-A-Caron, M. DuBose. Elec. News, vol. 40, no. 18, Sept. 15, 1931, pp. 35–39 and 51, 11 figs. Development of 1,250,000-hp. plant at junction of Saguenay and Shipshaw; general plan of development showing location of initial development of 260,000 hp. and later development of 1,000,000 hp.; some details of sluice tube, power house, gate hoists, generators, etc., are given.

United States. The Mokelumne Hydro-electric Project, E. A. Crellin. Elec. Eng., vol. 50, no. 9, Sept. 1931, pp. 705–712, 7 figs. California's latest hydroelectric development activities are centered in Mokelumne River property of Pacific Gas and Electric Co.; project involves complete redevelopment of river, from water surveys to power distribution, and will make available billion kilowatt-hours annually, 10 times output of 1902 development on same stream; principal power houses and substations are illustrated; plan and profile of project are given. Before Am. Inst. Elec. Engrs.

HYDROELECTRIC POWER PLANTS

Germany. Die Turbinen des Rheinkraftwerkes Ryburg-Schwoerstadt (Turbines of Rhine Power Plant Ryburg-Schwoerstadt). V.D.I. Zeit., vol. 75, no. 38, Sept. 19, 1931, pp. 1181–1187, 16 figs. Installation and operation of four Kaplan turbines developing 38,700 hp. at 75 r.p.m. each; dimensions and design of principal components, with particular regard to bearings; model tests for investigating most economic shape of concrete suction pipe, most favorable shape of blade, cavitation problems, etc.

Pumped-Storage. Waeggital Pumped-Storage Hydro-Electric Scheme. Engineering, vol. 132, no. 3425, Sept. 4, 1931, pp. 292–294, 4 figs. Power scheme near Zurich has annual output of 110,000 kw.-hr. generated in two stations mainly during winter months; dam closing gorge is of solid gravity type, 363 ft. high by 515 ft. long; pressure tunnel of circular cross-section and 12-ft. internal diam. is capable of carrying 1160 cu. ft. of water per sec.; Rempen power station has four vertical-shaft Francis-type spiral turbines, each with output of 22,500 hp. at speed of 500 r.p.m.; Siebnen station contains four turbines of same type with outputs of 14,750 to 17,500 hp. at 500 r.p.m.

I

INDUSTRIAL MANAGEMENT

Cost Accounting. How a Jobbing Plant Keeps Accurate Costs on all Work, W. S. Mosher. Iron Age, vol. 128, no. 16, Oct. 15, 1931, pp. 995–999 and 1020, 8 figs. Advantages of cost system of Mosher Steel & Machinery Co., Dallas, and Houston, Tex.; original order and distribution of departmental credit; job cost sheet; analysis of sales and cost of sales; perpetual inventory.

Motion Study. Motion Picture Camera in Micromotion Study, R. M. Barnes. Iron Age, vol. 128, no. 14, Oct. 1, 1931, pp. 866–867, and 902, 2 figs. Making time studies of operations of short duration on light drilling punch-press work, burring, polishing with camera making 1000 exposures per minute.

Organization. Building an Efficient Engineering Organization. Power, vol. 74, no. 10, Sept. 8, 1931, pp. 360–362, 6 figs. Methods employed by large engineering and management corporation in handling engineering projects so that work is properly coordinated and check maintained at all times on progress and cost.

Stabilization and. Scientific Management as a Philosophy and Technique of Progressive Industrial Stabilization, H. S. Person. World Social Economic Congress—Section 2, no. 1, 1931, 64 pp. Chart of scientific management in perspective as means of achieving progressive stabilization; synopsis; first part deals with past and present and contains stabilization of workplace, shop, human factors, marketing and general administration; second part deals with future and contains stabilization of industry, national industry, and international stabilization of industry; addendum includes chart and synopsis in French and German.

INDUSTRIAL PLANTS

Electric Power. Load Control in Industrial Plants, R. R. Ruggles. Power Plant Eng., vol. 35, no. 18, Sept. 15, 1931, pp. 935–937, 4 figs. Advantageous application of load regulation illustrated by hypothetical case of industrial plant with fluctuating load which purchases power from large central station, but also equipped to generate certain portion of its total load requirements; typical wiring diagram of automatic load regulator working on prime mover.

Switzerland. The Engineering Works of Escher Wyss & Company. Metal Industry (Lond.), vol. 39, no. 14, Oct. 2, 1931, p. 328. Works are in Zurich and date from year 1805, first machines made being for cotton-spinning industry; main shops have area of 161,000 sq. ft.; whole building is subdivided into 15 bays; details of foundries; boiler shops, etc.

The Maschinenfabrik Oerlikon. Metal Industry (Lond.), vol. 39, no. 14, Oct. 2, 1931, pp. 325–326, 1 fig. Works founded in early seventies, were originally intended for manufacture of woodworking tools, but later on metal-working machine tools were added; details of foundries; machine shops; locomotive shop; some of Company's products; electric traction.

INDUSTRIAL TRUCKS

Electric. Neuere Elektro-Fuehrersitzwagen (New Electric Trucks With Cab), E. Eichwald. Automobiltechnische Zeit., vol. 34, no. 35, Sept. 10, 1931, pp. 549–552, 8 figs. Design and performance data of trucks for load of 2000 kg. built by AEG, Bleichert & Co., Maschinenfabrik Esslingen and Siemens.

INTERNAL-COMBUSTION ENGINES

Combustion. Sur l'allumage et la combustion dans les moteurs rapides (Ignition and Combustion in High-Speed Engines), A. Grebel. Société des Ingénieurs de l'Automobile—Jl., vol. 4, no. 8, Oct. 1931, pp. 1482–1498, 6 figs. Fundamental problems in improving performance of spark-ignition and compression-ignition engine; precision of spark timing, and injection timing; factors controlling flame propagation and pressure rise.

Design. Stroke-Bore Ratio, G. Sartoris. Automobile Engr., vol. 21, no. 284, Sept. 1931, pp. 339–343, 5 figs. Mathematical analysis intended to show decrease of stroke-bore ratio should effect improvement in power-weight ratio, first, by considerable increase in ratio of power output to cylinder volume and secondly, by slight increase in ratio of cylinder volume to engine weight; greater engine speed made possible by reduction in piston friction losses and in big-end load factor as stroke-bore ratio is decreased.

Pistons. Anomalies de fonctionnement des Pistons et Segments (Improper Functioning of Pistons and Piston Rings), E. Seguy. Société des Ingénieurs de l'Automobile—Jl., vol. 4, no. 6, June 1931, pp. 1418–1428, 12 figs. Fundamental principles of piston design; provisions for conducting heat from piston head to wall; proper dimensioning of rings and lands; excessive oil pumping and wear, and their prevention.

Light Metal-Alloy Pistons and Rods in High-Speed Industrial Engines, B. J. Isidin. Motive Power, vol. 2, no. 9, Sept. 1931, pp. 22–25 and 45, 6 figs. Speed of oil and gasoline internal-combustion engines has been brought into higher range following availability of improved materials and necessity of obtaining increased power output without sacrificing space and weight; consideration of design to adopt better grades of material to solve problems of higher heat stresses and increase in dynamic bearing loads; as satisfactory means of reducing weight, author discusses use of aluminum, allowing heavier sections, preserving rigidity, and removing any thermal difficulties encountered in piston.

Rotary-Valve. A Rotary-Valve Engine. Autocar, vol. 67, no. 1872, Sept. 18, 1931, pp. 485–486, 2 figs. Operation of valve combining reciprocating and rotary motion developed by Duplex Piston Valve (New Zealand) Co.

Supercharging. Versuch der Vorausberechnung der Grenzleistung einer Kompressorverbrennungskraftmaschine (Attempt of Performance Calculation of Supercharged Internal Combustion Engine), E. Schida. Automobiltechnische Zeit., vol. 34, no. 22, Aug. 10, 1931, pp. 495–498, 3 figs. Procedure of calculation with practical examples; diagram illustrates energy budget; volumetric efficiency.

[See also AIRPLANE ENGINES; AUTOMOBILE ENGINES; DIESEL ENGINES; GAS ENGINES.]

IRON-FOUNDRY PRACTICE

Centrifugal Casting. The Speed of Rotation in the Centrifugal-Casting Process, J. E. Hurst. Foundry Trade Jl., vol. 45, no. 785, Sept. 3, 1931, pp. 145–147, 5 figs. Rotation about horizontal axis; rotation of molten metal; relationships of speed to diameter; table giving collected list of rotational speeds of various processes.

K

KINEMATICS

Compound Link Motions. Zusammengesetzte Gelenkgetriebe (Compound Link Motions), H. Blaise. V.D.I. Zeit., vol. 75, no. 39, Sept. 26, 1931, pp. 1223–1227, 45 figs. Classification of different types and application of compound drive; kinematic synthesis of oscillating and crank motion; methods of obtaining intermittent movements.

L

LEAD ALLOYS

Cold-Rolling, Effect of. The Effects of Cold-Rolling and of Heat-Treatment on Some Lead Alloys, H. Waterhouse and R. Willows. Engineering, vol. 132, no. 3427, Sept. 18, 1931, pp. 387–388, and (discussion) 381–382. Work is part of research on lead and lead alloys carried out on behalf of British Non-Ferrous Metals Research Assn.; its objects were to study behavior of number of lead alloys, containing at least 95 per cent of lead, during process of cold rolling to sheet, and to determine effect of storage at three different temperatures within atmospheric range on treatment. Before Inst. Metals.

LIQUIDS

Atomization. Ueber den Zerfall eines Fluessigkeitsstrahles (Disintegration of Liquid Jet), A. Haenlein. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 4, Apr. 1931, pp. 139–149, 18 figs. Investigation of phenomenon occurring with decomposition of liquid jet at different degrees of density, viscosity and surface tension for different jet diameters and speeds; tests were carried out on water, gas oil, glycerine, and castor oil; subject has bearing on how fuel in combustion chamber of compressorless Diesel engine is atomized, and how it mixes with surrounding air.

Compressibility of Water. The Compression of Liquid Water, R. C. H. Heck. Power, vol. 74, no. 12, Sept. 22, 1931, pp. 422–425, 6 figs. Compressibility of water no longer matter of purely academic interest; compressibility increases rapidly with temperature, so that feed pumps in modern high-pressure stations consume substantial amount of work in compressing feed water; comparative isotherms; adiabatic temperature rise; comparative curves.

LIGHTING

Industrial. Modern Industrial Lighting. Elec. World, vol. 98, no. 14, Oct. 3, 1931, pp. 616–617, 7 figs. Various samples of adequate lighting for general shop; machine shop; automobile body finishing plant; textiles plant; automobile assembly plant; and warehouses are illustrated.

LOCOMOTIVES

Bearings. Frictionless Bearings on Locomotives, J. E. Bjorkholm. Ry. Jl., vol. 37, no. 9, Sept. 1931, pp. 20–22, 2 figs. Practical discussion of frictionless bearings in car and locomotive operation; specific cases of satisfactory operation; components of train resistance; outline of various bearing tests.

Boilers. See BOILERS, Locomotive.

Diesel. A New Diesel Locomotive Development. Ry. Gaz., vol. 55, no. 5, July 31, 1931, p. 139, 3 figs. Novel design for heavy switching duty constructed by Swiss Locomotive and Machine Works, Winterthur, Switzerland; four-coupled wheels 2 ft. $9^1/_2$ in.; wheelbase 9 ft. $2^1/_4$ in.; weight, working order, 23 tons; high-speed Diesel engine, specially designed by makers for traction purposes, with six single-acting, four-stroke cylinders, airless injection of fuel, and developing 150 hp. at 850 r.p.m.; fuel consumption (gas oil, crude oil) does not exceed 0.4 lb. per hp-hr.

Diesel-Electric. Diesel-Electric Shunting Locomotive, Japanese State Railways. Ry. Gaz., vol. 55, no. 9, Aug. 28, 1931, pp. 264–265, 3 figs. Details of 2–6–2 locomotive built by Maschinenfabrik Esslingen and Maschinenfabrik Augsburg-Nuernberg A.G.; M.A.N. Diesel engines rated 600 b.hp. at 700 r.p.m.; six cylinder, four-stroke direct-coupled to d.c. generator with belt-driven exciter; coupled wheels $49^1/_4$ in.; total wheel base, 24 ft. $9^1/_4$ in.; maximum tractive effort, 23,153 lb.

Electric. New Haven Receives Ten Electric Locomotives. Ry. Age, vol. 91, no. 12, Sept. 19, 1931, pp. 443–444. Design provides increase of power without exceeding bridge-loading stress limits; locomotives designed for high-speed passenger service and to operate either on 11,000 volts a.c., or 660 volts d.c.; maximum speed 70 m.p.h.; total weight in running order 403,500 lb.; auxiliary motors and equipment.

Fuel Economy. Fuel Economy Through New Locomotive Devices. Ry. Jl., vol. 37, no. 9, Sept. 1931, pp. 14–18, 3 figs. High-pressure steam as applied to locomotive boilers; developments in increased tender capacity; control valve for limiting speed of feedwater pumps when main engine throttle is shut off; Worthington drifting control valve; use of boiler-check elbow extensions to reduce possibility of cold water encountering firebox sheets; application of sludge removers. Committee report before Int. Fuel Economy.

Valve Gears. Application of Marbec's Theory of Kinetic Diagrams to the Determination of the Velocities and Accelerations of the Different Articulations of Valve Gear, P. Place. Int. Ry. Congress Assn.—Bul., vol. 13, no. 9, Sept. 1931, pp. 731–760, 33 figs. Revision of graphical kinetics and theory of kinetic diagrams; application of theory of kinetic diagrams to determination of acceleration of Walschaerts valve gear.

LUBRICANTS

Lead Oleate. Lead Oleate Lubricants for Heavily Loaded Gears and Bearings, M. Reswick. Iron Age, vol. 128, no. 13, Sept. 24, 1931 pp. 816–819, 4 figs. Border-line lubricants particularly those containing lead oleate, developed to meet extreme pressure and speed conditions; lead oleate compound, it is shown, will maintain lubricating film beyond breakdown point of straight mineral oils; diagram of wear testing machine; chart comparing film strengths of lead oleate lubricants and mineral oils for various viscosities.

LUBRICATION

Friction Coefficients. Untersuchungen ueber molekularphysikalische Eigenschaften der Schmiermittel und ihre Bedeutung bei halbfluessiger Reibung (Investigations of Molecular-Physical Properties of Lubricants and Their Bearing on Semi-Viscous Friction), W. Bueche. Petroleum, vol. 27, no. 33, Aug. 12, 1931, pp. 587–601, 16 figs. Relation of lubricant research and molecular-physical theory; measurements of adsorption heat of oils; friction tests, results of which indicate that there is sharp experimental boundary between liquid and semi-liquid friction. Bibliography.

M

MACHINERY EXHIBITIONS

London. Shipping, Engineering and Machinery Exhibition—I, II, III, and IV. Machy. Market, nos. 1608, 1609, 1610, and 1611, Aug. 28, 1931, pp. 19–22 and 24, Sept. 4, pp. 21–25, Sept. 11, pp. 819–824, and Sept. 18, pp. 19–21, 53 figs. Aug. 28: Internal-combustion engines. Sept. 4: Air compressors and pneumatically operated machinery and tools, refrigerators, flexible-shaft-driven tools, woodworking machinery and machine tools. Sept. 11: Steam-raising and fuel-economizing plant; pumps, centrifugal separators and filters; pulverizers and furnaces. Sept. 18: Turbo-generators; electric deck and auxiliary machinery; electric furnaces and welding apparatus; instruments.

Shipping, Engineering, and Machinery Exhibition, Olympia. Machy. (Lond.), vol. 38, nos. 987 and 988, Sept. 10, 1931, pp. 761–772, and Sept. 17, pp. 800–810, 54 figs. Multi-tool sliding and facing lathe with hydraulic chuck and feed; Thiel punch and die shaper; Pittler maxi-speed turret screw machine; Naxos-Union hydraulic grinding machine; spur and helical gear grinder; automatic welding machines; high-speed production polishing machines; portable armor-plate, frame-plate slitting, punching, notching, and cropping machine; arc-welding machines; horizontal boring and facing machine; automatic multi-cut lathe with hydraulic in-feed to cross slides; grinding machines.

The Shipping, Engineering and Machinery Exhibition at Olympia. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 317–332, 44 figs. Considerations of design tendencies; exhibition is remarkable for its catholicity and, in this respect, lives up to its somewhat awkward and pretentious title; description of some outstanding exhibits; with possible exception of high-speed airless-injection engine, advances made in design of plant shown are not spectacular, but progress is none the less real.

MACHINERY FOUNDATIONS

Design. Richtige und fehlerhafte Maschinengruendungen (Correct and Faulty Machinery Bases), E. Rausch. V.D.I. Zeit., vol. 75, no. 36, Sept. 5, 1931, pp. 1133–1137, 23 figs. Fundamental aspects of design with particular regard to proper balancing of masses; attachment of machine to base; methods of preventing transmission of vibration for different construction materials; examples illustrate consequences of improper arrangement including unsuitable soil, rocks, respectively, and tiles; foundations of turbines.

MALLEABLE-IRON CASTINGS

Manufacture. The Manufacture and Properties of Malleable Iron Castings. Foundry Trade Jl., vol. 45, nos. 785 and 786, Sept. 3, 1931, pp. 143–144, and Sept. 10, pp. 160–161, 1 fig. Sept. 3: Uses and manufacture of malleable castings; melting; graphitization by heat-treating process; annealing or malleablizing; types of annealing furnaces; fallacious ideas concerning malleable iron. Sept. 10: Properties of malleable iron; chemical and mechanical composition; mechanical properties; machinability; heat treatment.

MATERIALS

X-Ray Analysis. Neue Methode zur Untersuchung von Faserstrukturen und zum Nachweis von inneren Spannungen an technischen Werkstuecken (New Method for Study of Fiber Structures and Detection of Inner Stresses), F. Regler. Zeit. fuer Physik, H. Scheel., vol. 71, no. 5–6, Aug. 29, 1931, pp. 371–388, 12 figs. Report from Experimental Institute for X-ray testing of materials of Vienna; application of X-ray analysis to study of rails, bridge elements, machine parts, etc., without damaging specimens investigated.

MATERIALS HANDLING

Rubber Factories. Mechanical Conveyor Systems Designed for Handling of Materials in Rubber Manufacturing Plants, E. J. Burnell. Rubber Age, vol. 29, no. 10, Aug. 25, 1931, pp. 456–458, 5 figs. Survey of various automatic materials-handling apparatus designed for efficient straight-line production; standardization of equipment means lower production costs.

MECHANICS

Rotating Disks. De berekening van snel roteerende schijven (Calculation of Disks Rotating at High Speed), H.'t Hart. Polytechnisch Weekblad, vol. 25, no. 39, Sept. 24, 1931, pp. 614–619, 9 figs. Theoretical mathematical analysis pertaining to forces acting in and on disks and their required mechanical strength; theory applicable to grinding wheels, high-speed pulleys, etc.

METALS

Cold Rolling. The Design of Rolls for Cold Roll Forming Machines—IV, D. A. Johnston. Metal Stampings, vol. 4, no. 9, Sept. 1931, pp. 727–728 and 748, 1 fig. Chart for determining detail dimensions of common types of rolls.

Cold Working. Limitations in Cold-Working in a Press, E. V. Crane. Iron Age, vol. 128, no. 14, Oct. 1, 1931, pp. 872–875, 3 figs. Importance of critical temperature as boundary between hot-working and cold-working; variation of tensile strength with temperature of nickel wire in both ductile and strain-hardened states; static compression tests on lead, tin, aluminum, and zinc at room temperature; rate and uniformity of plastic working.

Why Cold Working Changes Properties of Metal, E. V. Crane. Iron Age, vol. 128, no. 10, Sept. 3, 1931, pp. 626–630, 5 figs. Why physical properties of metal change as they do in process of cold-working (as for example in deforming sheets), with or without intermediate annealing; slip movement in any crystal may vary over wide range, in adjusting metal to conditions imposed by cold-working or by action of high temperature.

Fatigue Testing. Das Verhalten einiger Werkstoffe bei dynamischer Biegungsbeanspruchung (Behavior of Some Materials Under Dynamic Bending Stress), M. Hempel. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 9, Sept. 1931, pp. 327–334, 16 figs. Preliminary tests and determination of external losses; results of damping measurements; vibration rupture; change in frequency with increasing load; damping of different metals, including iron, steel, brass, and aluminum, is determined in relation to amplitude and fatigue stress (load-fluctuation coefficient).

Fusion, Latent Heat of. On the Nature of the Latent Heat of Fusion, K. Honda and H. Masumoto. Tohoku Imperial Univ.—Science Reports, vol. 20, no. 3, July 1931, pp. 342–352, 2 figs. Starting from idea of "dynamic internal pressure," latent heat of fusion has been calculated for various elements, 23 in number; it was found that calculated values agree satisfactorily with those observed; from thermodynamic consideration it was concluded that greater portion of latent heat of fusion consists of energy of atomic rotation. (In English.)

MOTOR TRUCKS

Articulated. 45-Ton Articulated Eight-Wheel Vehicle. Engineering, vol. 132, no. 3428, Sept. 25, 1931, pp. 400–403, 12 figs. Latest model developed by Scammell Lorries, Ltd., with load capacity of 45 tons; designed to carry "abnormal indivisible" loads; type consists essentially of power unit and detachable carrier, complete vehicle being neither tractor nor tractor-trailer in ordinary meaning of both terms; power unit comprises 4-cylinder engine with clutch and gear box on three-point suspended subframe; output is 75 b.hp. at 1700 r.p.m. and 80 b.hp. at 1800 r.p.m.

O

OPEN-HEARTH FURNACES

Combustion Control. Combustion Control, G. D. Conlee. Iron and Steel Engr., vol. 8, no. 9, Sept. 1931, pp. 389–393. Methods of controlling: rate of supply and amount of fuel supplied to furnace per heat; air supply for combustion of fuel; drafts and pressures at various points in flues and downtakes; temperatures in flues; composition of exhaust flue gases. Before Am. Iron and Steel Elec. Engrs.

P

PIPE, CAST-IRON

Centrifugal Casting. A New Sand Spun Pipe Plant. Engineer, vol. 152, no. 3950, Sept. 25, 1931, p. 322, 6 figs. partly on p. 324. Plant at works of Staveley Coal and Iron Co. designed to produce 80,000 tons per annum of sand-spun iron pipes of sizes from 4 to 12 in. diam. length being in each case 16 ft.: process and equipment employed.

PLASTICS

Die Casting. Der Spritzguss organischer Massen in der Elektrotechnik (Die Casting of Organic Masses in Electric Industry), F. Pabst. Elektrotechnische Zeit., vol. 52, no. 38, Sept. 17, 1931, pp. 1189–1191, 4 figs. Process of metal die casting is transferred to organic plastics; material used so far stands out by its mechanical, electrical, and chemical strength; method for manufacture of high-quality insulators of complicated design.

POWER PLANT EQUIPMENT

Advances in. Boilers, Superheaters and Economizers. Nat. Elec. Light Assn.—Pub., no. 156, Sept. 1931, 56 pp., 68 figs. There has been no outstanding departure from previously established trends during past year; various refinements in design indicate tendency to more carefully balance cost and performance; several methods of superheat and reheat temperature control are now in use; design and operating data of recent boiler installations is tabulated and some interesting operating practices are reported by member companies.

PRESSES

Pneumatic. Press for Chassis Side Members. Engineering, vol. 132, no. 3425, Sept. 4, 1931, p. 279, 5 figs. on pp. 278 and 286. Press constructed by Maschinenfabrik Weingarten vormals H. Schatz, Germany, for production of chassis side members up to 19 ft. 9 in. long; by selection of suitable materials, it is possible to employ cold pressing with increased production rate, and side members produced are in no way inferior to hot-shaped pressings; press is capable of exerting pressure of 1100 tons, and both blanking and punching can be performed in one operation.

PRESSURE GAGES

Wind Pressure. Windmessung auf Abraumfoerderbruecken und Verladekranen (Wind Measurements on Loading Trestles and Cranes), H. Kirsten II. V.D.I. Zeit., vol. 75, no. 34, Aug. 22, 1931, pp. 1079–1081, 5 figs. Design and operation of wind-pressure indicator built by Askania Works, Berlin; remote recording equipment.

PRESSURE VESSELS

Welding. Fusion Welding as Applied to Pressure Vessels. Boiler Maker, vol. 31, no. 9, Sept. 1931, pp. 242–244, 6 figs. Present practice of fusion welding in pressure-welding design; welding equipment and practice; specific applications. Committee report before Master Boiler Makers' Assn.

PULVERIZED COAL

Firing. Accepted Practice in Pulverized-Fuel Firing. Power, vol. 74, no. 8, Aug. 25, 1931, pp. 266–267, 3 figs. Successful operation of pulverized-fuel plants largely depends on proper training of operating personnel; adoption of improved methods of igniting fires reduces danger of blowbacks; need for more general observance of safety rules.

PUMPING PLANTS

Equipment. Great Economies Achieved by Modern Pumping Equipment, W. M. White. Eng. News-Rec., vol. 107, no. 13, Sept. 24, 1931, pp. 486–487, 3 figs. Improvements in steam turbines and electric power generation; high efficiency within large range obtained by modern centrifugals; motor-driven pumps replace pumping engines in Detroit; up-to-date pumping equipment conserves space.

PUMPS, CENTRIFUGAL

Design. Berekening van de theoretische opvoerhoogte van centrifugaalpompen (Computation of Theoretical Lift of Centrifugal Pumps), P. J. Dijksman. Ingenieur, vol. 46, no. 36, Sept. 4, 1931, pp. W137–W139, 3 figs. Decrease of lift caused by action of blades on liquid is calculated and from equations developed, conclusions are drawn as to design of rotor.

R

RAIL MOTOR CARS

Hungary. Nuova Automotrice elettrica con motore Diesel (New Electric Rail Motor Car With Diesel Engine), P. Coletti. Atti del Sindacato Provinciale Fascista Ingegneri di Milano, vol. 9, no. 6, June 1931, pp. 201–204. 28 per cent of rail mileage and 20 per cent of passenger volume handled by light cars with trailers; economies with Diesel powered cars.

Improvements. Railway Improvements. Engineer, vol. 152, no. 3948, Sept. 11, 1931, p. 294. Writer considers intensive service of rail cars, conceived with freedom from convention, like coach operators have done, and applied with broad outlook, as solution of large part of railway difficulties; partial electrification may follow, when, if ever, intensive service has reached its limit of development.

Operation. Lehigh Valley Operates All Local Service With Rail Cars. Ry. Age, vol. 91, no. 9, Aug. 29, 1931, pp. 327–328, 1 fig. Average savings, as compared with steam operation, in two years and six months equal original motor car cost; trailers of light-weight construction; principal operating statistics of Lehigh Valley rail motor cars.

Pneumatic Tires. L'adaptation du bandage pneumatique aux automotrices ferroviaires (les Michelines) (Adaptation of Pneumatic Tire to Rail Motor Cars), G. Delanghe. Genie Civil, vol. 99, no. 5, Aug. 1, 1931, pp. 111–115, 9 figs. Experiences in operation of rubber-tired rail motor cars built by Michelin Co.; advantages of rubber tires consisting particularly in improved acceleration, braking ability with used wear of track and rolling stock.

Pneumatic-Tired Rail Coaches. Engineer, vol. 152, no. 3947, Sept. 4, 1931, p. 243, 2 figs.; see also Engineering, vol. 132, no. 3425, Sept. 4, 1931, p. 294, 1 fig. Demonstrations carried out by Michelin et Cie, of Clermont-Ferrand; use of pneumatic tires claimed to be advantageous for reason that coefficient of friction of rubber on steel is such as to allow weight of vehicle to be reduced considerably; tire is of special form; deflation of tire in event of puncture is prevented by wooden hoop on outer half of tire between cover and tube; wear is about 1 mm. for 10,000 km.; coach is really motor omnibus on rails and is handled in same way.

Testing. Testing Railway Motor Cars, W. F. Kasper. Baldwin Locomotives, vol. 10, no. 2, Oct. 1931, pp. 25–35, 16 figs. Testing equipment and procedure as employed by Fairmont Railway Motors, Inc.; typical performance plotted from track car dynamo-meter records. (In English and Spanish.)

REFRIGERATING MACHINERY

Design. Trends in the Design of Refrigerating Coils, R. S. Wheaton. Power, vol. 74, no. 13, Sept. 29, 1931, pp. 456–457, 2 figs. Increasing use of ammonia coils operating on flooded principle, with float valve controls for maintain-

ing predetermined level in liquid ammonia in equipment; heat-transfer rates in coils; efficiency differs in two coil types.

ROLLING MILLS

Cogging Mill. Three-High Cogging Mill With Automatic Tilter and Mechanical Reversing Devices, E. Kaestel. Iron and Coal Trades Rev., vol. 123, no. 3314, Sept. 4, 1931, p. 327, 3 figs. Features of type of plant built by Krupp-Gruson works, of Magdeburg, Germany; output of cogging mill equipped with these auxiliary devices is about 30 tons per hr.; special advantage of tilters.

Strip Mills. Makes Cold-Rolled Strip Steel at Lower Cost. Iron Age, vol. 128, no. 14, Oct. 1, 1931, pp. 868–871 and 901, 6 figs. Manufacture of cold-rolled strip steel in new cold-rolled strip plant at Cuyahoga works of American Steel & Wire Co., Cleveland; use of electric furnaces for bright annealing between roughing and finishing passes; new tandem sets are capable of taking reduction up to 80-per cent, in one pass through each of four-mill stands.

S

SAWS

Metal-Working. Governor Feed Gear for Hack-Sawing Machines, E. G. Herbert. Engineering, vol. 132, no. 3430, Oct. 9, 1931, pp. 461–462, 4 figs. Gear produced by E. G. Herbert, Ltd., which automatically regulates feed of saw through work as section being cut changes in form, and thus makes it possible to put maximum pressure on widest section without altering speed.

Woodworking. Les perfectionnements apportés aux machines de débitage des bois (Improvement in Design of Wood Cutting Machines), J. Razous. Génie Civil, vol. 99, nos. 7, 8, and 9, Aug. 15, 1931, pp. 166–169, Aug. 22, pp. 192–194, and Aug. 29, pp. 211–213, 45 figs. Aug. 15: Operation and design of different types of stationary and portable saws; importance of shape of saw teeth for different types of wood. Aug. 22: Band saws and circular saws; Aug. 29: Planning machines.

SHAFTS

Deformation. Detecting Deformation of Shafts, O. P. Van Steewen. Am. Mach., vol. 75, no. 14, Oct. 1, 1931, pp. 530–532, 3 figs. New methods and machinery developed in Germany for conducting tests as to degree of perfection attained in forging and machining of hollow turbine shafts, by A.E.G. in cooperation with Askaniawerke, Berlin; measurements of interior tension in material.

SHEET METAL

Handling. New Method Cuts Cost of Handling Sheet Steel, C. B. Crockett. Steel, vol. 89, no. 15, Oct. 5, 1931, pp. 31–33, 4 figs. Handling of steel sheets from car to storage; result of installing synchronized system using two types of mobile equipment was reduction of cost of 85 per cent and faster, neater, safer, handling operation.

Sheet-Steel Manufacture. British Versus American Sheet Steel, E. S. Lawrence. Heat Treating and Forging, vol. 17, no. 10, Oct. 1931, pp. 955–958, 6 figs. Comparison between British and American methods of processing full finished sheet steel, particularly for use in automobile bodies; microphotographs illustrate hot rolled and normalized sheet structure; low carbon deep drawing and double box annealed sheet structure; irregularity of grain structure in majority of high grade sheet steels as double box annealed in Great Britain indicates necessity of basic normalized sheet.

Testing. Routine Testing of Thin Sheet Metals. Machy. (Lond.), vol. 38, no. 986, Sept. 3, 1931, pp. 717–719, 8 figs. Principal types of mechanical tests; curve showing Erichsen values for deep-drawing mild steel; Erichsen values for brass sheet and strip; Erichsen values for phosphor-bronze sheet; Avery temper test; tensile and elongation figures for different tempers of brass; Erichsen values for aluminum sheet and strip; Erichsen values for copper sheet and strip; Vickers pyramid diamond numerals.

Testing Deep Drawing Qualities of Sheet Metal, H. W. Gillett. Metals and Alloys, vol. 2, no. 4, Oct. 1931, pp. 214–220 and (discussion) 220–222, 12 figs. Effect of plastic flow under combined stress; residual stresses produced by previous plastic deformation; structural changes in material, heat treatment. Bibliography.

SMOKE ABATEMENT

Ordinances. A Digest of Smoke Ordinances in American Cities and Canada. Power, vol. 74, no. 13, Sept. 29, 1931, pp. 462–471. Compilation of smoke ordinances based upon survey initiated by H. K. Kugel, smoke commissioner of Cleveland, Ohio, as activity of Fuels Division of American Society of Mechanical Engineers, tabulation and amplification of data having been carried out through cooperative effort of A.S.M.E. and editorial staff of Power.

STEAM

Condensation. Heizwirkung von kondensierendem Heiss- und Sattdampf (Heating Effect of Condensing Superheated and Saturated Steam), E. Kirschbaum. Archiv fuer Waermewirtschaft, vol. 12, no. 9, Sept. 1931, pp. 265–266, 4 figs. Results of tests on heat exchangers with straight and spirally wound heating tubes show that no great difference exists between heating effect of superheated and wet steam.

Properties, Tables of. Eine neue Zustandsgleichung des Wasserdampfes (Equation of State for Steam), H. Hausen. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 9, Sept. 1931, pp. 319–326, 3 figs. Calculation based on quantum theory; empirical equation; equations for specific volumes, heat content and entropy; extrapolation; comparison with skeleton tables of 2nd International Steam Table Conference in Berlin.

STEAM CONDENSERS

Cleaning. How Often Do You Clean Your Condenser? J. W. Anne. Power Plant Eng., vol. 35, no. 20, Oct. 15, 1931, pp. 1018–1019, 2 figs. Outline of methods for finding most economical interval at which certain condensers should be cleaned; chart for determining cost of steam due to dirty condenser tubes.

Heat Transmission. Der Waermedurchgang in Oberflaechenkondensatoren (Heat Transmission in Surface Condensers), G. Jungnitz. Waerme, vol. 54, no. 39, Sept. 26, 1931, pp. 721–725, 6 figs. Results of tests on small condenser; use of heat-transmission coefficient for evaluation of surface condensers; physical explanation of experimental results.

Der Einfluss des Luftgehaltes auf den Waermeuebergang bei kondensierendem Dampf (Influence of Air Content on Heat Transfer of Condensing Steam), E. Langen. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 10, Oct. 1931, pp. 359–369, 16 figs. Theoretical considerations; arrangement of apparatus, especially for measuring wall temperature; other measured values; test pipe; fundamental equations; results and evaluation of tests; coefficient of heat transfer; wall temperature along pipe periphery; conclusions.

Der Waermeaustausch zwischen Wand und Wasser im Rohr (Heat Transfer From Tube to Water), W. Nusselt. Forschung auf dem Gebiete des Ingenieurwesens, vol. 2, no. 9, Sept. 1931, pp. 309–313, 4 figs. Review of tests by Burbach, and by Eagle and Ferguson; it is claimed that results in both cases can be expressed by author's potency formula. See also Engineering Index 1930, pp. 871 and 1651, for references to work of investigators quoted.

Testing. Condenser Research Shows Effect of Tube Arrangement, F. A. M. Wuelfinghoff. Power, vol. 74, no. 15, Oct. 13, 1931, pp. 534–537, 5 figs. Results indicate that coefficient of heat transfer in surface condenser closely proportional to condenser rating, if water-inlet temperature and condenser water rate are constant; with given water inlet temperature vacuum depends, within limits, almost entirely on condenser water rate; curves illustrating heat transfer coefficient at various condenser water rates; tests with built-in baffling; comparative condenser performance with and without baffling.

STEAM ENGINES

High-Pressure—Lubrication. Steam Cylinder Lubrication of Modern High-Pressure Engines, A. F. Brewer. Power, vol. 74, no. 16, Oct. 20, 1931, pp. 564–567, 7 figs. Lubrication of steam cylinders frequently requires consideration of effect of high pressure and superheated steam upon lubricant, as well as effect of lubricant in condensate; economy dictates use of superheated high-pressure steam and effective utilization of heat contained in exhaust or condensate; to render exhaust more adaptable for feed water or process-heating purposes, oil separators or grease extractors are coming into general use in factory plants employing reciprocating steam engines.

Mixed-Steam. Berechung einer Mischdampf-Kraftmaschine (Calculation of Mixed Steam Engines), F. Bosnjakovic. V.D.I. Zeit., vol. 75, no. 28, Sept. 19, 1931, pp. 1197–1201, 6 figs. Properties of mixtures of liquids and mixtures of gases; theoretical investigation of action of mixed steam and steam engines by means of entropy diagram; graphical methods; efficiency found to be somewhat less than that of water-vapor process.

STEAM PIPE BENDS

Flexibility. Flexibility of Plain and Creased Pipe Bends, A. M. Houser and S. Hirschberg. Power, vol. 74, no. 16, Oct. 20, 1931, pp. 568–571, 5 figs. Engineering discussion of comparative flexibility of creased and plain pipe bends based upon tests made on bends of these types having same major dimensions and in answer to article by W. Paul in June 2 issue of magazine, results have been applied to standard formula and used to compare flexibility of small radius creased expansion bend with larger radius plain expansion bend; effect of tangent length on flexibility was not considered in this later comparison.

STEAM PIPE LINES

Stresses. Bending Stresses in Steam Pipes, R. Livingston. World Power, vol. 16, no. 93, Sept. 1931, pp. 226 and 228–230, 4 figs. Pipe connection to steam turbine generally simple bend with or without straight lengths beyond bend; ordinary tangential stresses due to working pressure of steam should be combined with longitudinal bending stresses to obtain total working stress in material of pipe.

STEAM POWER PLANTS

Auxiliaries. Power Consumption of Boiler House Auxiliaries, P. H. N. Ulander. Inst. Fuel—Jl., vol. 4, no. 18, Aug. 1931, pp. 399–411 and (discussion) 411–415, 16 figs. Performance curves of boiler auxiliaries which are all of centrifugal type; consideration of capital expenditure, demand and energy charges in complete analysis of economies of boiler-house auxiliaries; tabular review of auxiliary power consumption in various plants.

Back-Pressure. Wirkungsgrad und Dampfverbrauch von Gegendruckturbinen axialer Nauart (Efficiency and Steam Requirement of Axial Back-Pressure Turbines), W. Gruber, Waerme, vol. 54, no. 41, Oct. 10, 1931, pp. 751–755, 7 figs. Formulas for calculation of efficiency and steam consumption of multi-stage and single-stage turbines.

Development. Etat actuel de l'évolution de la turbine a vapeur (Present Status of Development of Steam Turbine), P. Dubertret. Technique Moderne, vol. 28, nos. 19 and 20, Oct. 1, 1931, pp. 645–651 and Oct. 15, pp. 677–684, 23 figs. Trend in design with reference to theoretical fundamentals; maximum efficiency possible, safety; high pressure and superheating; influence of design on efficiency, etc.

Fuel Economy. Mittel zur Verbilligung der Energiekosten bei schwankender Last (Means of Reducing Costs of Power With Fluctuating Load), F. Huettner. Waerme, vol. 54, nos. 38 and 39, Sept 19, 1931, pp. 705–710, and Sept. 26, pp. 729–732, 7 figs. Means of preventing losses due to fluctuating load; problem of economic drive of auxiliary machinery; influence of more important cost reducing measures.

High-Pressure. Experience at Station A With 1250-Lb. Steam Pressure, R. C. Powell. Elec. World, vol. 98, no. 13, Sept. 26, 1931, pp. 544–547, 4 figs. Experience in starting up 1250-lb. steam plant, results obtained as to fuel consumption, and some general conclusions regarding use of high pressure in San Francisco Co. show that cost is no more than for lower pressures; no inherent difficulties due to pressure are found; operating experience shows flexibility and fuel economy over lower-pressure plants.

Patent Litigation. End of the Greatest Patent Conflict, F. Satora. Engineer, vol. 152, no. 3952, Oct. 9, 1931, p. 389. Reference to conflict relating to steam-turbine patents of Erste Bruenner Maschinenfabrik, which forms basis of Brno (Bruenn) novelty invented by J. Loesel; number of opponents arose to contest patent claims and pleas of nullity were brought; Erste Bruenner Maschinenfabrik recently withdrew Polish patent, as negative results of all lawsuits up to present left ever-decreasing hope of favorable conclusion; this voluntary action can be taken as definite termination of famous conflict.

STEAM POWER PLANTS, INDUSTRIAL

Costs. W. & J. Sloane Know Their Power Costs. Power, vol. 74, no. 15, Oct. 13, 1931, pp. 538–539, 3 figs. Outline of system of charting record of steam and electric meters by W. and J. Sloane Mfg. Co., for actual costs of steam and electric energy consumed by process departments in Trenton, N. J., linoleum factory.

Design. Industrial Boiler Plant Design, H. Bleibtreau. Power, vol. 74, no. 14, Oct. 6, 1931, pp. 493–495, 6 figs. Comparison of various industrial plant designs; importance of planning and economical layout; cost figures and typical designs tending to reduce overhead.

Iron and Steel Plants. The Youngstown

Sheet and Tube Co. Modernizes Its Power Plant. Power Plant Eng., vol. 35, no. 17, Sept. 1, 1931, pp. 876–884, 8 figs. At Campbell Works, replacement of 85 old boilers by six modern units burning blast-furnace gas, supplemented by pulverized coal resulting in concentration of steam generation in one plant; use of 400-lb. steam only in new 36,000-kw. turbine-generator plant and 180,000 cu. ft. min. turbo-blower plant with evaporators making 150-lb. process steam in closed feedwater circuit; rearrangement of water pumping system handling 86,000,000 gal. per day; electrification of steel mill drivers; foregoing lead to great reductions in costs of making, distributing, and utilizing steam and power; list of equipment.

STEAM TRAPS

Automatic. Automatic Steam Trap. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 342–343, 2 figs. Trap, having no moving parts and of exceptionally light weight, is made by Gustav F. Gerdts, Bremen, Germany; characteristic features of Gestra trap is that it discharges through labyrinth packing of special design.

STEAM TURBINES

Bleeder. Control of Bleeder Turbines, S. H. Hemenway. Elec. Jl., vol. 28, no. 9, Sept. 1931, pp. 530–534, 7 figs. With low bleeder pressures of few years ago, regulator that would maintain more or less steady pressure in bleeder line was satisfactory; now bleeder pressure must be maintained within one per cent for any constant amount bled, and such regulation must be maintained at two different bleeder zones; also, load must be held substantially constant; system of control is described.

Efficiency. Standards of Efficiency for Steam Turbines, G. Stoney. Engineering, vol. 132, no. 3428, Sept. 25, 1931, pp. 398–399, 3 figs. Advantages of use of heat drop as basis of comparison; by standards of efficiency described, one plant can, under limitations mentioned, be compared with another under different steam conditions.

Operation. Turbines. Nat. Elec. Light Assn.—Pub., no. 151, Aug. 1931, 62 pp., 67 figs. Report includes: 1930 operating records for 324 large turbines and for 10 turbines operating above 1000 lb. gage steam pressure; results of tests on 5 turbines ranging from 65,000 to 165,000 kw. capacity; operating companies' statements on fouling of turbine buckets.

Specifications. I.E.C. Publication on Steam Turbines—I—Specification. Int. Electrotech. Commission—Pub., no. 45, 1931, 15 pp., numerous figs. Rating; governing characteristics; speed adjustment; emergency cut-off speed; steam (or heat) consumption; lubricating oil; parallel running; vibration and noise; critical speed; steam tables; standard equipment; hydraulic test for parts exposed to boiler pressure; information to be supplied with inquiry or order for steam turbines; suggested standard ratings and steam pressures; graphic symbols for heat-power systems. (In English and French.)

STEEL

Age Hardening. Die Alterung von weichem Flusstahl nach Verformungen bei 600 bis 700 Grad (Aging of Ingot Steel After Deformation at 600 to 700 Deg. Cent.), F. Sauerwald. Stahl und Eisen, vol. 51, no. 37, Sept. 10, 1931, pp. 1150–1151. Kind of notched-bar upsetting test at 600 and 680 deg. was carried out, and after deformation, aging tendency at room temperature was ascertained by determination of notch toughness.

Chromium. See CHROMIUM STEEL.

Chromium-Nickel. See CHROMIUM-NICKEL STEEL.

Fatigue. Plastic Strain in Relation to Fatigue in Mild Steel, B. P. Haigh and T. S. Robertson. Engineering, vol. 132, no. 3427, Sept. 18, 1931, pp. 389–390, 2 figs. Fatigue tests were carried out in Haigh electromagnetic pull-and-push machine with capacity of 10 tons max. load and 7 tons range of load at 3000 cycles per min. frequency; in all, 15 specimens were tested with different cycles of stress, having different ranges and different ratios between extreme values of stresses. Before Brit. Assn.

Heat Treatment. Determinations of Time Required for the Heating of Steel, T. J. Ess. Iron and Steel Engr., vol. 8, no. 7, July 1931, pp. 317–321, 7 figs. Conditions entering into problems concerning heating of steel; methods of Grober, and of Gurney and Lurie, are applicable to heating for ordinary forging and rolling; Janitzky's method seems best for heat treating, or other comparatively low temperature work requiring uniform heating.

Manufacture. Manufacture and Testing of Forging Quality Steels, N. L. Deuble. Blast Furnace and Steel Plant, vol. 19, no. 10, Oct. 1931, pp. 1348–1352 and 1373, 6 figs. Precautions for obtaining steels free from pipe, free from detrimental surface defects such as seams, slivers and scabs, and also free from excessive porosity; correct methods of handling billets and ingots; size and analyses guaranteed to cold shear in hot rolled condition; etch tests and microscopic examination.

Properties at High Temperatures. Properties of Steel at High Temperatures, R. Willows and F. C. Thompson. Metallurgia, vol. 4, no. 22, Aug. 1931, pp. 109–112, 6 figs. Effect of prolonged stress upon mechanical properties of two spheroidized steels at elevated temperatures. Bibliography.

The Behavior of Steel at High Temperatures, V. B. H. Mason. Manchester Steam Users' Assn.—Memorandum by Engineer-in-Chief for Year 1930, Apr. 1931, 70 pp., 69 figs. Methods employed in determination of limiting creep stresses; results of various tests give fair idea of steel properties at high temperatures; need for test standardization; failures of boiler material; details and micrographs of cracked shell plates of Lancashire boiler.

Yield Point. The Phenomenon of Tensile Yield in Mild Steel and Iron, J. G. Docherty and F. W. Thorne. Engineering, vol. 132, no. 342, Sept. 4, 1931, pp. 295–297, 15 figs. Experiments carried out in Engineering Laboratory of Royal Naval College, Greenwich, to determine conditions under which real phenomena of yield may be studied with standard apparatus. Before Brit. Assn.

The Upper and Lower Yield Points in Steel Exposed to Non-Uniform Distributions of Stress, G. Cook. Engineering, vol. 132, no. 3426, Sept. 11, 1931, pp. 343–345, 5 figs. In paper before Royal Society, previously indexed from Metallurgist, Aug. 28, 1931; author described investigation to determine stresses at yield point, and during initial stages of plastic strain in mild steel subjected to uniform and non-uniform stress; in present paper, he summarizes and discusses results. Before Brit. Assn.

STOKERS

Operation. Factors on Successful Stoker Operation. Power, vol. 74, no. 8, Aug. 25, 1931, pp. 264–265, 2 figs. Selection of proper type and size of unit, and maintaining of uniform and proper thickness of fuel bed are important; trend toward use of thinner fires and higher induced draft with underfeed types; use of water walls and preheated air affects maintenance cost; efficiency maintained through improvements.

Underfeed. Electro-Hydraulic Drive for Underfeed Stokers, J. F. Cooke. Power Plant Eng., vol. 35, no. 18, Sept. 15, 1931, pp. 947–948, 2 figs. Specific examples of flexibility in stoker operation; wide variation in range in ratings of heating coal obtained by Hele-Shaw hydraulic transmission; design, construction, operating details of hydraulic system.

Betriebserfahrungen mit Unterschubrosten (Operating Experiences With Underfeed Stokers), H. Schlicke. Brennstoff und Waermewirtschaft, vol. 13, no. 9, Sept. 1931, pp. 165–167. Investigation of combustible residues; removal and crushing of slag pats; tilting grate vs. shaft; details of drive and fuel feed.

United States. Automatische Kleinkohlenfeuerungen in den Vereinigten Staaten von Amerika (Automatic Small Coal Furnaces in United States), K. A. Mayr. Feuerungstechnik, vol. 19, nos. 9 and 10, Sept. 15, 1931, pp. 137–140, and Oct. 15, pp. 160–162, 9 figs. Over 30 firms engaged in construction of automatic coal burners for household purposes, and at least just as many in manufacture of automatic stokers for larger central heating and smaller industrial plants; various types are described.

STRESSES

Wind Pressure. Einiges ueber Windlasten (Wind Pressure Loads), O. Graf. V.D.I. Zeit., vol. 75, no. 39, Sept. 26, 1931, pp. 1230–1232, 6 figs. Mathematical discussion of observations and results of laboratory tests, made in Europe of wind pressure upon posts, trusses, framework, etc.; variation of wind velocity with altitude.

T

TANKS

Welding. Ein geschweisster Stahlgrossbehaelter (Large Welded Steel Tank), E. Gentilomo. Montanistische Rundschau, vol. 23, no. 16, Aug. 16, 1931 (Stahlbau), pp. 65–68, 4 figs. Container for molasses built by Waagner Biro Corp., Vienna, for alcohol factor refinery of G. & W. Loew in Angern, Austria; diam. 28.5 m.; capacity 7100 cu. m.; arc-welding process was chiefly employed.

THERMODYNAMICS

Problems. Etude aérodynamique et nomographique de quelques problèmes thermiques (Aerodynamic and Nomographic Study of Some Thermodynamic Problems), W. Margoulis. Chaleur et Industrie, vol. 12, nos. 134 and 135, June 1931, pp. 269–277, and July, pp. 352–362, 11 figs. Mathematical study of similarity of thermic and aerodynamic phenomena; friction theory of heat transmission in pipes; comparison of theory and experiment; review of principal research work. Bibliography.

TRACTORS

Diesel. Billiger Schlepp-Dienst mit einer Diesel-Zugmaschine (Low Cost Service by Diesel Tractor), W. Dette. Automobile Rundschau vol. 33, no. 18, Sept. 20, 1931, pp. 366–368, 5 figs. Design and performance data of tracklaying Hanomag tractor; 4-cylinder engine with bore and stroke of 105 by 150 mm. developing 36 hp. at 1100 r.p.m.; weight 3700 kg.; cost data.

V

VALVES

Steam. Flexible Disc Stop Valve. Engineering, vol. 132, no. 3427. Sept. 18, 1931, p. 388, 3 figs. Fitting, known as Saunders streamline valve, is made by Rees Roturbo Manufacturing Co.; as regards principle, it may be compared most nearly with common laboratory method of interrupting flow in rubber tube by means of spring clip; advantages claimed for valve are that it has no working parts exposed to fluid passing through it; there is no stuffing box or gland to keep tight, and can be reconditioned, by replacement of disk, by unskilled labor.

W

WAGES

Wage-Payment Plans. Time Limit System of Wage Incentives and How It Works, G. J. Stegemerten. Mill and Factory Illustrated, vol. 9, no. 1, July 1931, pp. 27–29, 8 figs. Time-study procedure for wage-payment plans; practice in Westinghouse Elec. and Mfg. Co., East Pittsburgh, Pa.

WASTE ELIMINATION

Factors Causing Waste. Wastes—How to Control Them, J. J. Berliner. Mill and Factord Illustrated, vol. 9, no. 1, July 1931, pp. 42–44 any 98, 4 figs. Outline of factors which cause waste in industrial plants; control of material consumption; recording quantities daily; reference made to specific cases.

WATER SOFTENING

Zeolite Process. Crystalit, ein neuer Zeolith im Dienste der Wasserenthaertung Crystallite, a New Water Softening Zeolite), H. G. Bodenbender. Vom Wasser—Jahrbuch fuer Wasserchemie und Wasserreinigungstechnik, vol. 4, 1930, pp. 154–160, 1 fig. Properties of new synthetic zeolite, known as crystallite; manufacture of crystallite; description of crystallite water-softening plant and special apparatus.

WELDING

Electric. See ELECTRIC WELDING, ARC.

Pressure Vessels. See PRESSURE VESSELS.

Tanks. See TANKS.

WIND TUNNELS

Great Britain. Compressed-Air Wind Tunnel of National Physical Laboratory, E. F. Relf. Engineering, vol. 132, no. 3429, Oct. 2, 1931, pp. 428–433, 14 figs. partly on supp. plate. Reasons which led to building tunnel of this type; design and construction of tunnel; nature of apparatus which is to be used to make measurements in it. Before Brit. Assn.

WOOD

Bending, Technique of. Zur Holzbiegetechnik (Wood Bending Technique), A. Prodehl. V.D.I. Zeit., vol. 75, no. 39, Sept. 26, 1931, pp 1217–1222, 18 figs. Determination of bending properties of wood based on investigation of bending machines; requirements for correct bending of wood represented by mathematical relations and graphs; work at Technical University of Dresden.

HIGH Temperature HIGH Pressure STEAM at *Plant Atkinson*

Located on the Chattahoochee river, near Atlanta, Plant Atkinson adds a great steam generating station to those already serving customers of Georgia Power Company over approximately two-thirds of Georgia. This plant not only greatly increases the available capacity, but permits a more efficient utilization of the company's hydro-electric plants and provides additional protection against power interruptions from any cause.

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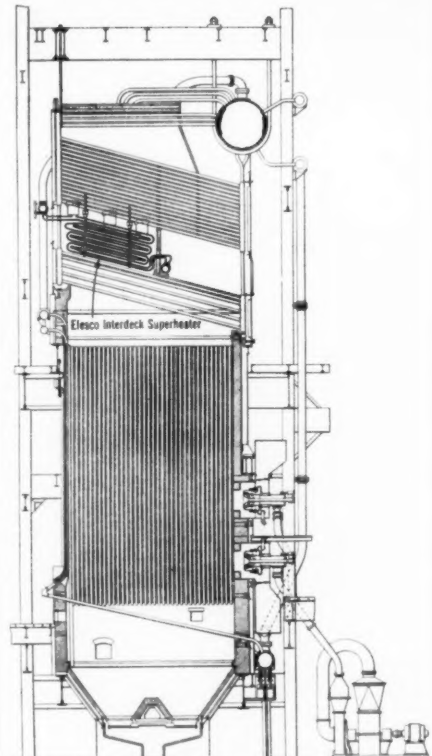

One 3020-hp. Walsh & Weidner cross drum boiler, is equipped with an Elesco superheater for the following conditions:

Steam temperature....750 deg. F.
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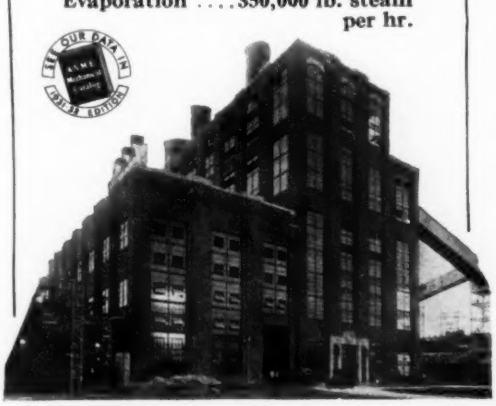
Pressure........460 lb. per sq. in.
Evaporation ....350,000 lb. steam per hr.



The superheater is of the interdeck type, incorporating the special Elesco feature of the outside location for the superheated-steam header. This reduces fluctuation in header temperature to a minimum and obviates the danger from overheating by exposure to hot gases. The units, being of the multiple-loop, single-pass design, make possible incorporation of large superheating capacity in a limited space in close proximity to the boiler furnace. The design provides for large capacity, with comparatively even high temperatures required for high-efficiency operation.

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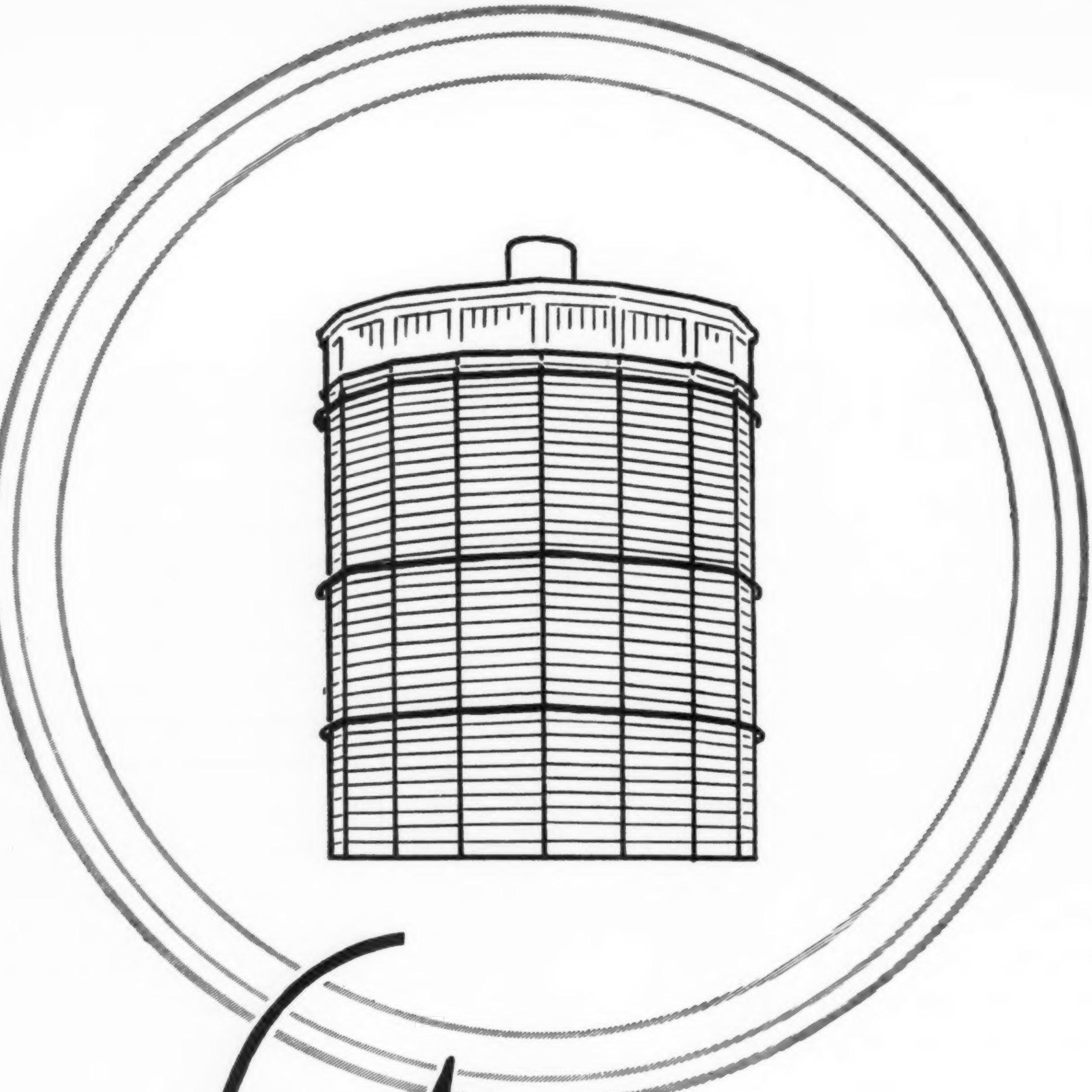

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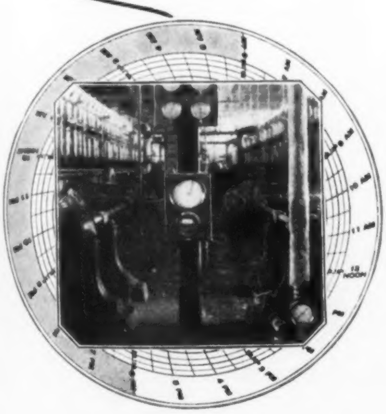
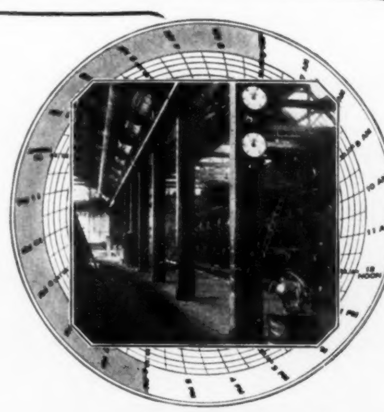


Process Cost.



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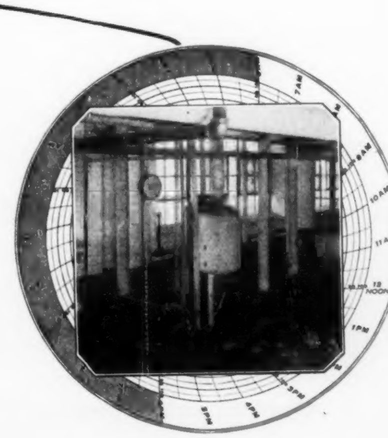
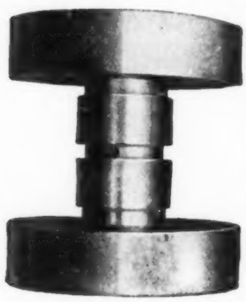


Process Cost

THE JOHNSON FRICTION CLUTCH


Double Clutch with Pulleys

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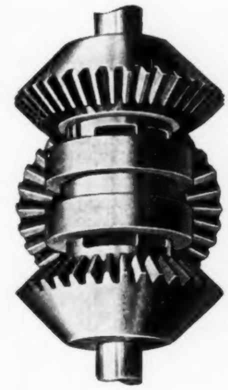
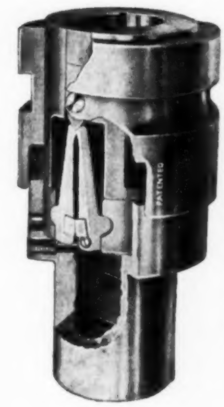

Double Clutch between Bevel Gearing

THE
SUPER
JOHNSON
CLUTCH



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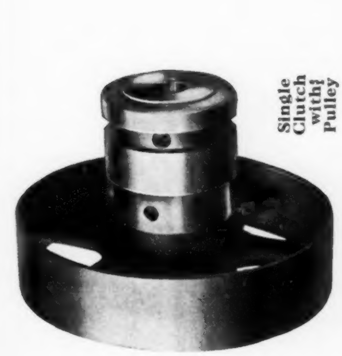
Single Clutch with Pulley

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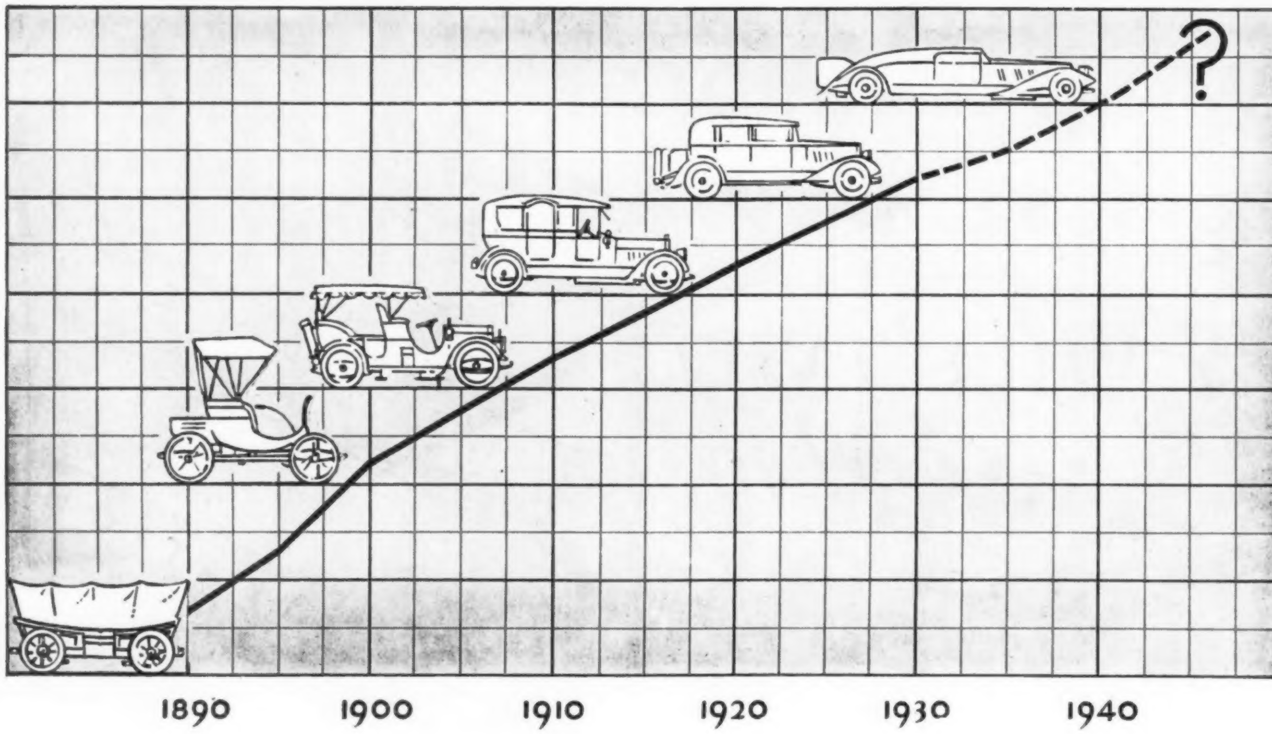

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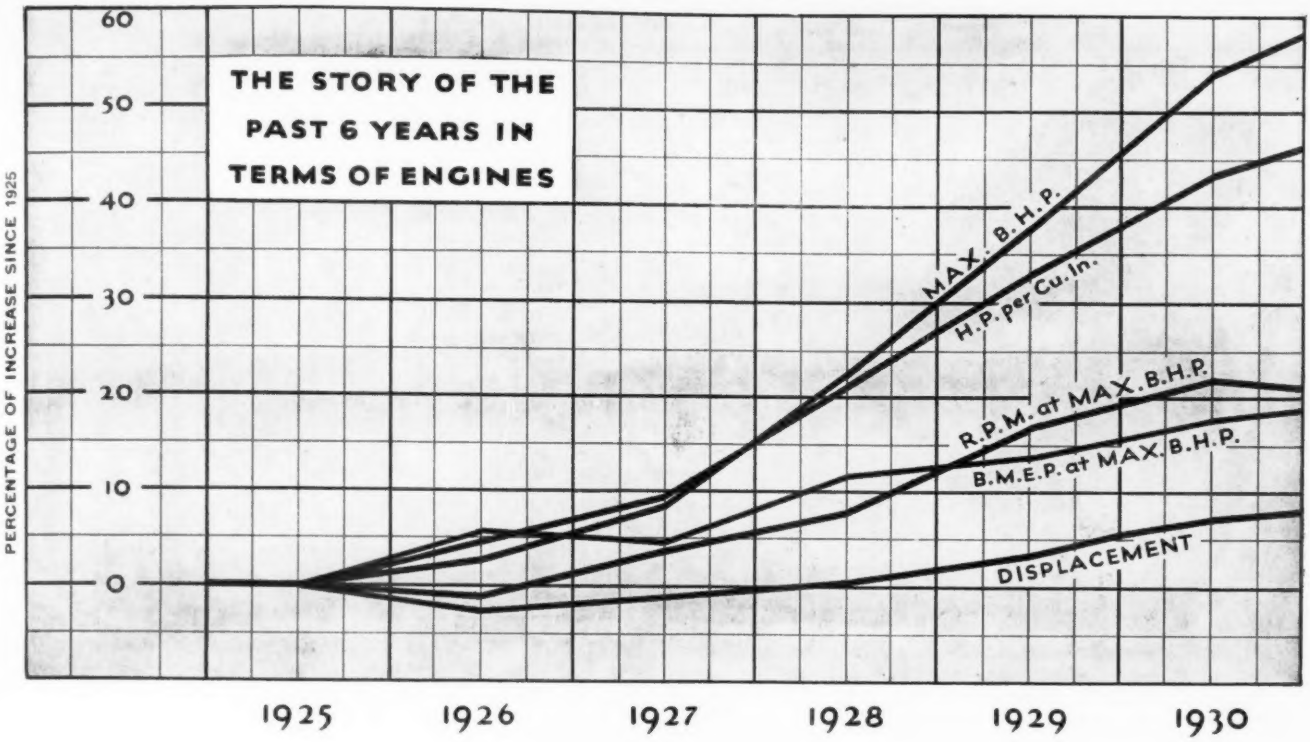

For all American cars listing their values in trade publications, the story of six years' development shows increases: in engine displacement, brake mean effective pressure at maximum brake horsepower, revolutions per minute at maximum brake horsepower, horsepower per cubic inch of displacement, and maximum brake horsepower. The increasing efficiency of each cubic inch of engine space is a prophetic curve.

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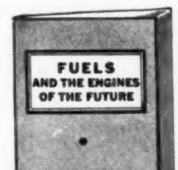

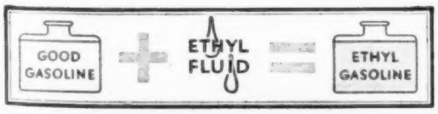

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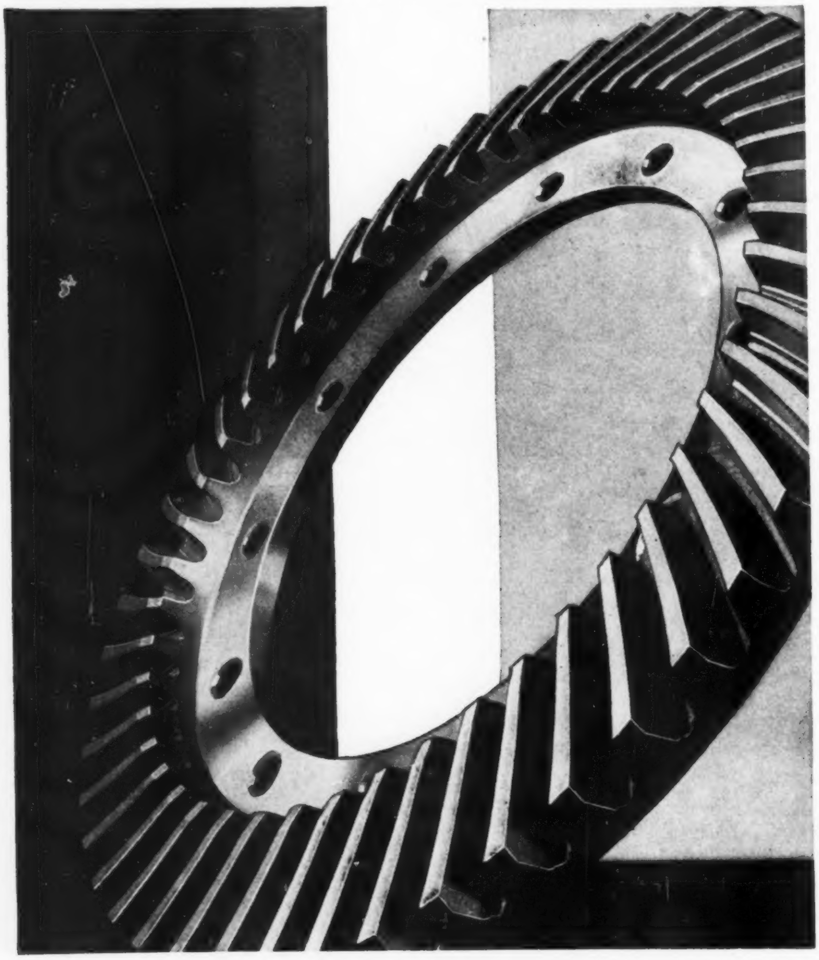

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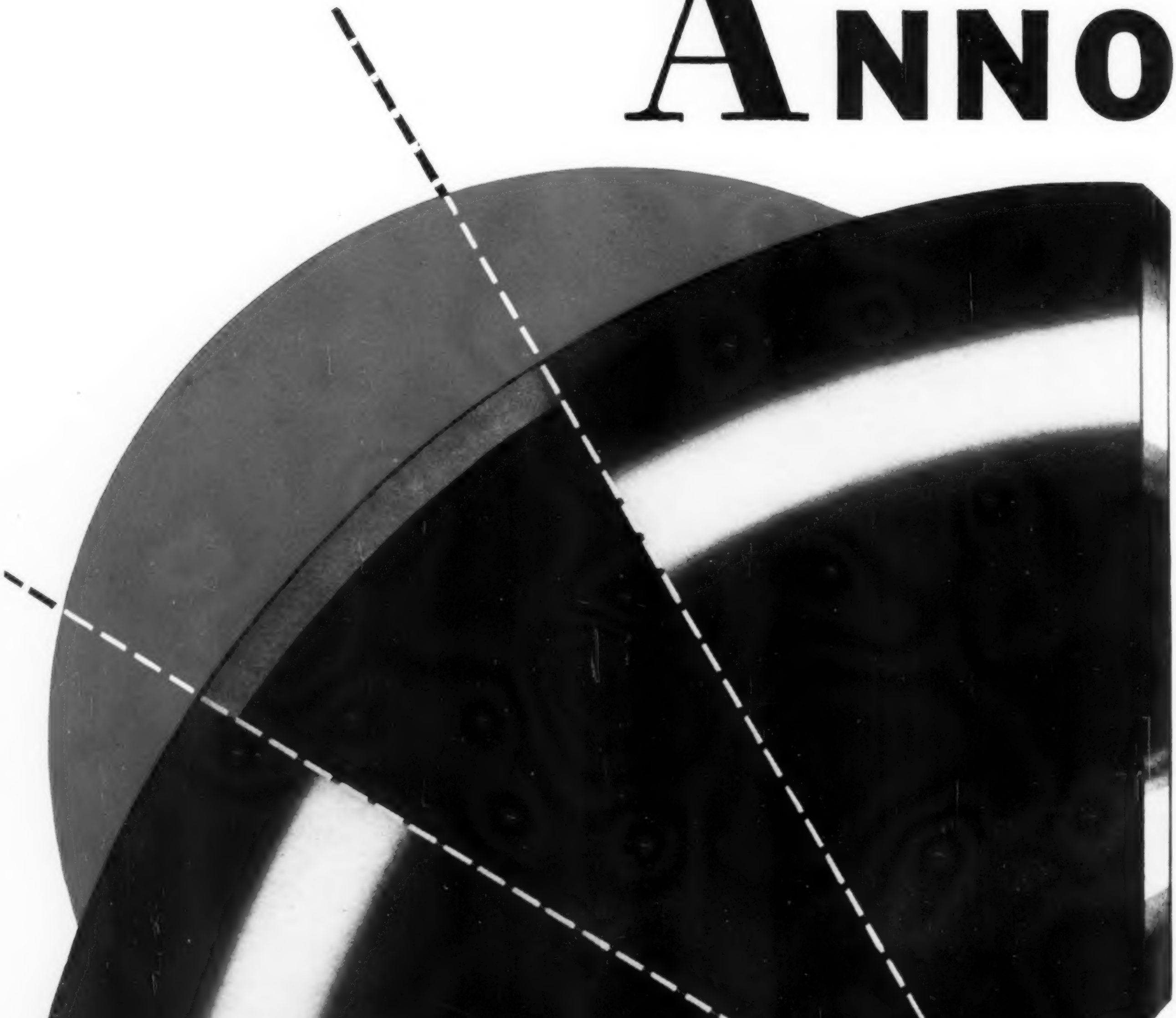

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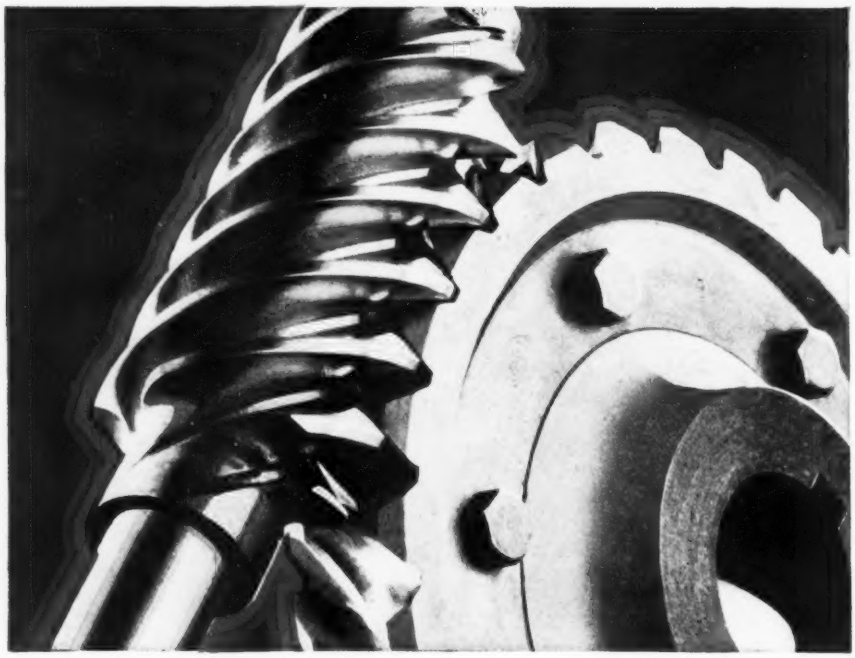

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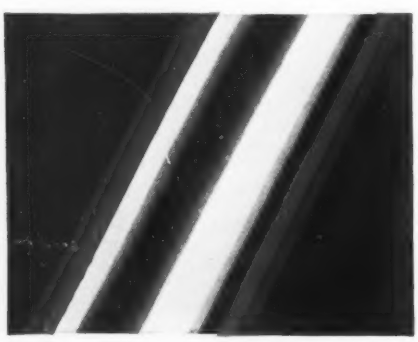

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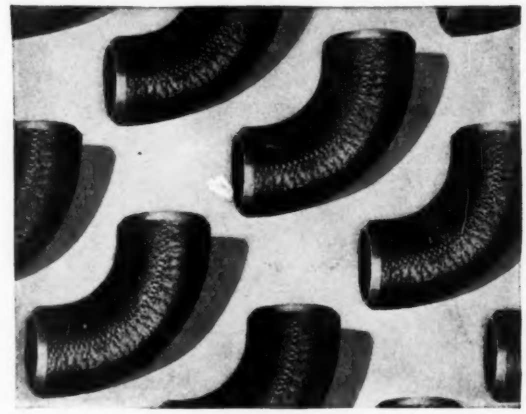

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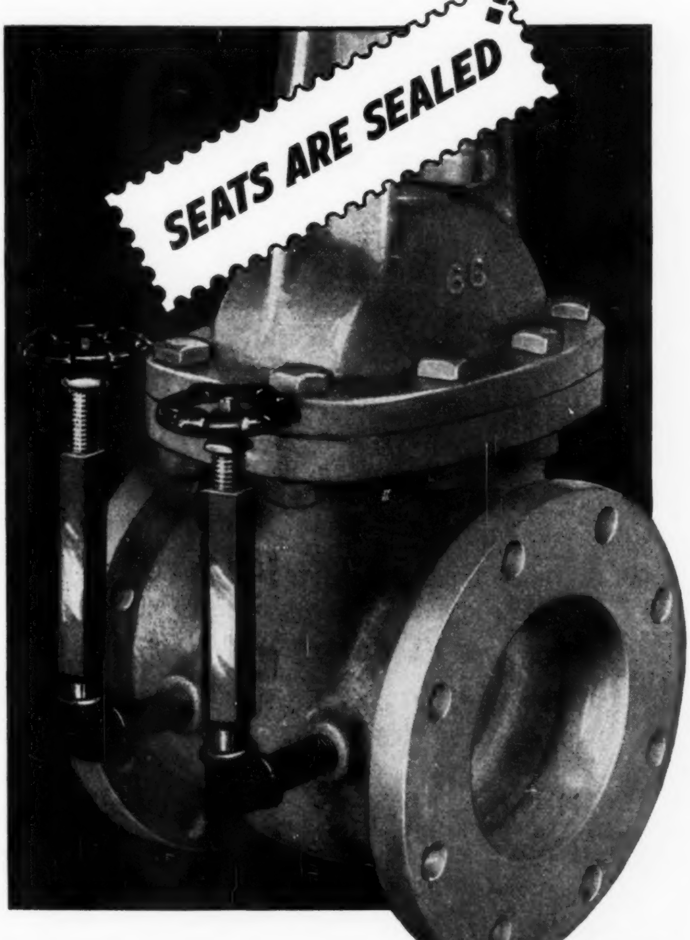
If corrosion is one of your troubles, this film of lubricant-seal is a protection to the seats. It also overcomes sticking due to deposits or long disuse. A turn on the lubricant guns frees the wedge, virtually pries it loose.

Special lubricant-seals have been developed for particular services. This is put up in standard sized cartridges in convenient pocket-fitting boxes. Loading is very easy.

The *LUBROTITE* feature is available in all Reading-Pratt & Cady Iron and Electric Cast Steel Gate Valves.



Patents Pending

READING-PRATT & CADY COMPANY, *Inc.*
Bridgeport, Connecticut

Boston, Charlotte, Chicago, Cleveland, Detroit, Hartford, Houston, New York, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Tulsa

ACCO
An Associate Company of the American Chain Company, Inc.

MAIL TODAY FOR ILLUSTRATED DESCRIPTIVE BOOKLET

READING—PRATT & CADY
Lubrotite
IRON AND STEEL GATE VALVES

READING-PRATT & CADY CO., Inc., Bridgeport, Conn.
Please send by return mail, without any obligation whatever, complete facts about "Lubrotite" Gate Valves.

Company..

Address..

Name and Position..................................

HOMOWELD

The Modern Vogt Method of Welding Pressure Vessels

For twenty years the Henry Vogt Machine Company has been fabricating their own products by fusion welding, out of which has come a wealth of experience in producing quality welds. As a result the Vogt welding plant of today, with its personnel and equipment, offers *HOMOWELD*, for the fusion welding of pressure vessels.

The *HOMOWELD* is a metallurgically complete union, free from all harmful defects such as nitride needles, porosity, cracks, slag inclusions, incomplete fusion, segregations, or other flaws.

Special equipment and a skilled welding technique with constant supervision during fabrication assures maximum strength and serviceability of any *HOMOWELDED* boiler drum or pressure vessel constructed for the refinery, chemical, or power field.

We fabricate vessels for every pressure and temperature in any size or shape within transportation limits. Such products are fully insurable and comply with all requirements of the A. S. M. E. code for fusion welding.

The *HOMOWELD* Bulletin W-1 is now being distributed. If you have not received your copy, ask for it.

SEE OUR DATA IN A.S.M.E. 1931-32 EDITION

HENRY VOGT

LOUISVILLE,

Branch Offices; New York Chicago

Manufacturers of: Oil Refinery Equipment, Drop Forged Steel Machinery,

Just Off the Press...

A COMPLETE, authoritative treatise on Hot Lime Soda Water Softening as applied to modern boilers. Profusely illustrated with photographs and diagrams. Describes the latest improvements in design, such as accurately proportionating Chemical Feeds, etc. An interesting and valuable booklet!

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Water Treating Equipment

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New York, N. Y.

Gentlemen:—Yes, I would like a copy of the Hot Lime Soda Water Softening booklet. This will not obligate me.

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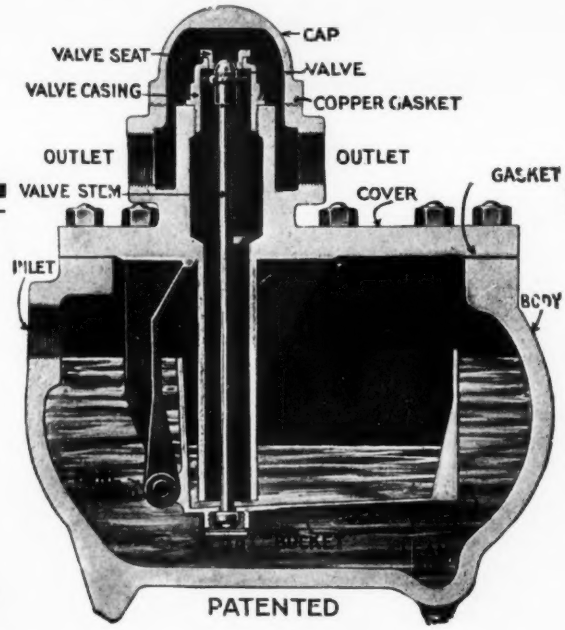
TWENTY-THREE SALES OFFICES THROUGHOUT THE UNITED STATES

P-159

Dec. 1931



Interior view of Standard Genuine Squires Steam Trap.

Note the easy access to valve seat of Squires Trap. Without interfering with or breaking any pipe connections, you can inspect or change the valve seat in a few minutes.

Let SQUIRES Steam Traps

end your condensate troubles

Hundreds of plant operators will tell you that the Genuine Squires Steam Trap works like a charm in cleaning up troubles caused by condensation in steam, air or gasoline lines.

This is so because the Genuine Squires has few working parts, is easily accessible, and operates with high efficiency due to its powerful bucket action and quick opening and closing.

The trouble-free, money saving service of this popular trap has been repeatedly demonstrated in high pressure heating systems, laundry machinery, steam separators, dry kilns, and many other installations.

If you are not familiar with the advantages of the Genuine Squires Trap ask us to send you Catalog H. It also describes the Squires Reducing Valve, Boiler Feed Water Controller and other economy-increasing Specialties.

Send for Catalog H for full information on Squires Steam Specialties

SEE OUR DATA IN A.S.M.E. Mechanical Catalog 1931-32 EDITION

Insist on the Genuine Squires Steam Specialties

TRADE MARK

THE C.E. SQUIRES COMPANY E.40TH ST. & KELLEY AVE., CLEVELAND

ANOTHER MIDWEST DEVELOPMENT THAT

MIDWEST

Look for this knurl marking—it identifies Midwest Welding Ells that are made from genuine Reading Puddled Iron skelp. A special label also aids in identification.

★

READING PUDDLED IRON—the genuine wrought iron that has proved its resistance to corrosion by generations of outstanding service. It is identified by the copyrighted knurl mark of the Reading Iron Company.

THE GREATER MIDWEST PIPING SERVICE

HERE are other Midwest Welding Fittings that also help reduce the cost and improve the design of many types of piping systems. At present, these fittings are carried in stock made only from the same material as mild steel pipe. Complete data including dimensions and prices are given in Bulletin WF-2; write the nearest Midwest office for a copy.

MIDWEST WELDING HEAD

The ellipsoidal form reduces unit stress in the metal to a minimum. The long tangent puts the circumferential weld to the pipe entirely in tension—it is not subjected to shear and bending. Application is much easier and a neat appearing job is assured. Standard weight and extra heavy Heads carried in stock from 3" to 24".

FILLS AN IMPORTANT PIPING NEED

WELDING ELLS

made from

Reading *Puddled Iron

FOR the many jobs where genuine wrought iron pipe is advantageous—and where welding assures a better or cheaper installation than other methods of connecting pipe—Midwest now offers welding ells made from genuine Reading Puddled Iron skelp. At present, the sizes are from 2″ to 10″ inclusive; both standard weight and extra heavy are available.

Midwest *Genuine Wrought Iron Welding Ells—like those made from mild steel pipe material—have a number of distinctive and important advantages. Prominent among these are *dimensional accuracy* and *uniformity*—the ells have full and true circular cross sections and are to exact radius. This results from a special *compression* sizing operation that is exclusive with Midwest. The manufacturing procedure also holds the wall thickness uniform and within very close tolerances; this thickness is never less than the nominal pipe wall thickness.

The included angle of every Midwest Welding Ell is exactly 90° or 45° and center-to-face dimensions are accurately maintained—because of ingenious fixtures used in machine-beveling the ends. Inspection is very rigid and each ell is subjected to a hydrostatic test pressure 25% greater than the mill test of the corresponding pipe.

Long tangents are another distinctive advantage—the pipe and fitting can be lined up more quickly and accurately. One quarter inch of tangent is provided for each inch of fitting diameter; thus an 8-inch ell has tangents 2 inches long. Particularly in the larger sizes, an appreciable saving results from the decreased length of pipe required.

Each Midwest Welding Ell is made from *one piece* of Reading Puddled Iron skelp by a special process developed and patented by Midwest; there is one welded longitudinal seam along the inner circumference. The final working of the fitting is in *compression* at a forging heat, thus normalizing and refining the skelp and the weld—it is not extruded or stretched.

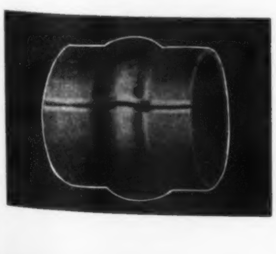
Since these Midwest Welding Ells are made from Reading Puddled Iron skelp, they have the same corrosion resistance, the same coefficient of expansion and the same welding characteristics as *genuine wrought iron pipe.

Get in touch with the nearest Midwest office (or any office of the Reading Iron Company) for complete information regarding Midwest *Genuine Wrought Iron Welding Ells.

Midwest Piping & Supply Co., Inc.

Main Office: 1450 South Second St., St. Louis

Offices: Chicago, 208 South La Salle Street . . . Houston, 600 Bringhurst Street . . . Los Angeles, 520 Anderson Street . . . New York (Ballwood Division), 30 Church Street . . . Tulsa, 733 Mayo Building

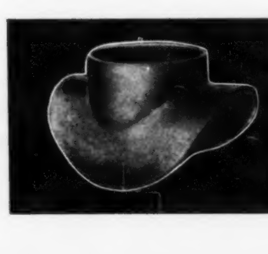


MIDWEST WELDING SLEEVE

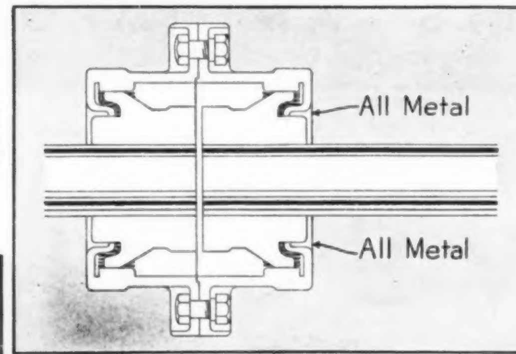
Used to reinforce a butt line weld between two pieces of pipe, it relieves the butt weld of any bending stress and much of the tensile stress to which it would otherwise be subjected. Transverse recess in sleeve permits its application over the conventional butt line weld. Sleeves are carried in stock from 4″ to 24″.

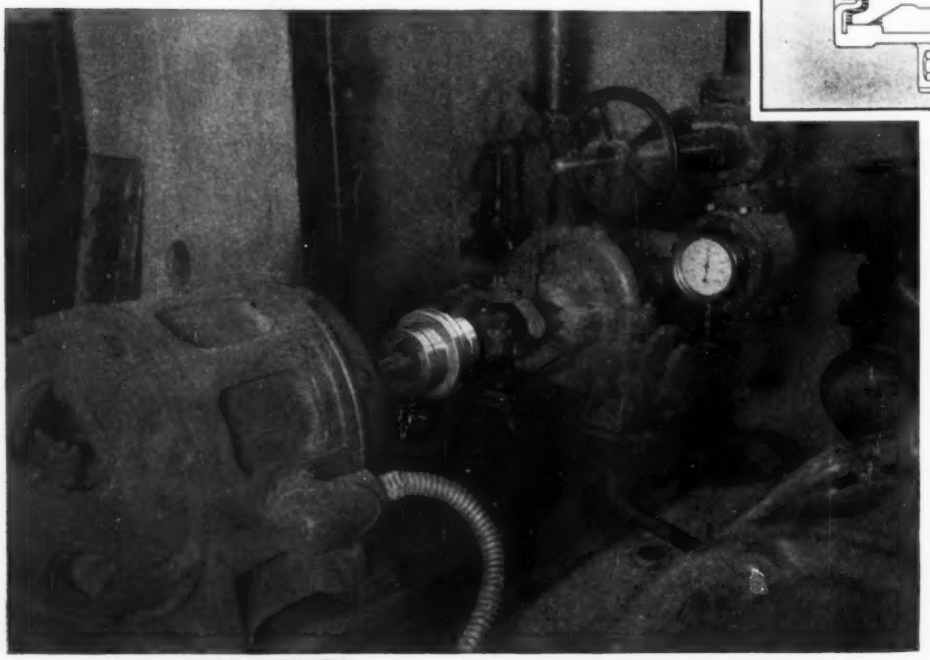
MIDWEST WELDING SADDLE

It not only reinforces the junction of neck and body of a welded header, but also compensates for the weakening of header body that results from loss of the metal cut out for the neck opening. Tests proved this saddle materially increases the strength of a welded header over customary gusset plate construction. Made in sizes from 4″ x 2″ to 24″ x 24″.



Dust-Proof and Stays Dust-Proof



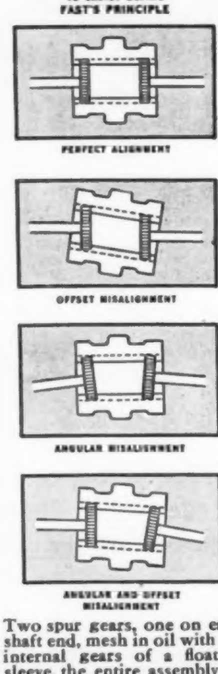


HERE'S WHY

Metal bearing rings on metal hubs. Metal-to-metal bearing seals the coupling permanently—excluding dust, grit, fumes, water, and eliminating this hazard of wear.

Fast's Coupling connecting motor and centrifugal pump at the Calumet & Arizona Mining Co., Warren, Ariz.

EXAGGERATED DIAGRAMS TO EASILY DEFINE FAST'S PRINCIPLE



Two spur gears, one on each shaft end, mesh in oil with the internal gears of a floating sleeve, the entire assembly revolving as one unit, misalignment being taken up between the gear faces.

ONLY actual metal-to-metal contact can *permanently* seal a coupling against the wearing action of dust, fumes, abrasives, moisture, dirt and grit present in the atmosphere of factories.

See the diagram above. Metal bearing rings on metal hubs. Metal-to-metal bearing seals the coupling. No perishable materials to harden, dry, break-down or let in dust. Fast's patented metal bearing rings seal out dust, fumes, moisture and other machine wearing substances *forever.*

Oil carries the load in Fast's Coupling, cushioning and lubricating between the gear-teeth, and because the oil stays fresh, clean, 100% grit-free, Fast's Coupling gives far longer and more efficient service.

Years of service have proven that Fast's *Self-Aligning* Coupling "lasts as long as the connected machines."

FAST'S *Self-Aligning* COUPLINGS

PERMANENTLY DUST-PROOF

THE BARTLETT HAYWARD CO. ◆ SCOTT & McHENRY STS. ◆ BALTIMORE, MD.

Accurate check on water rate is one sure method of regulating costs . . .

Accurate knowledge of boiler-feed-water consumption is a certain method of determining the boiler evaporation rate. Its importance is recognized wherever operating costs are watched and *must be kept down.*

SIMPLEX

TRADE MARK REG. U.S. PAT. OFF.

But—Boiler feeding is never uniform or smooth. Accurately measuring and indicating such a flow is possible only with a sensitive meter.

The new Simplex Model MGO Meter, although of sound and simple construction, is fast and accurate in recording variations in flow. There is no tendency to "over-riding"—nor to lag—no sluggish response—but a fast, stable, sensitive movement in synchronism with every variation in rate of feeding. This has been definitely proved again and again by records of Simplex Meters under varying conditions in the field.

The Simplex Chart is an accurate graphic picture of true flow conditions.

Simplex Meters are the choice of those who value quality and accuracy above initial cost.

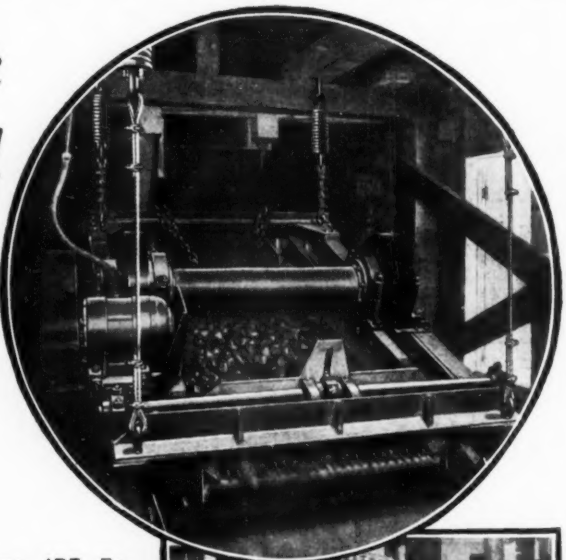
Write for your copy of Bulletins 32-A and 42.

SIMPLEX VALVE & METER COMPANY
6753 UPLAND STREET, PHILADELPHIA, PENNA.

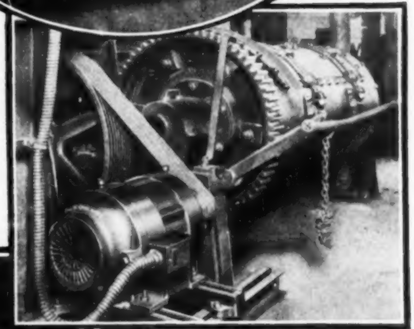
Ask Your Maintenance Man!

..where the troublesome drives in your plant are!

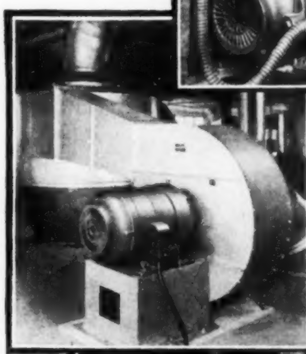
Ask him where dust, dirt, moisture, dripping water, or even destructive gases are present. Those drives in out-of-the-way places, where motor windings become clogged or moisture soaked.... Ask him to study the Allis-Chalmers Enclosed Fan-cooled Motors, approved by the Underwriters for dusty locations, and where explosive gases are present.... Ask him to notice how these motors have the same sturdy construction, liberal design, and unexcelled insulation, that for years have been characteristic of Allis-Chalmers motors.... Ask him to note also, how these enclosed fan-cooled motors are as easily accessible, and with no greater number of parts, than a standard open motor.... Ask him to write for Leaflet 2124, on the Enclosed Fan-cooled Motor, and Leaflet 2125A, on the Explosion-proof Motor.



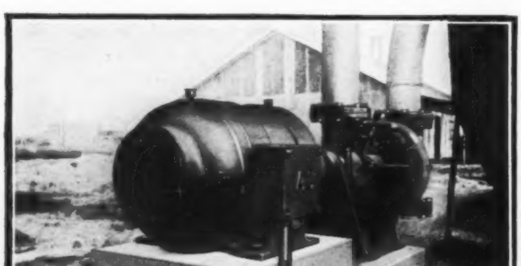
Type ARZ Enclosed Fan-cooled Motors are used on all Allis-Chalmers Centrifugal Vibrating Screens because these motors are best protected against dust, dirt and water.



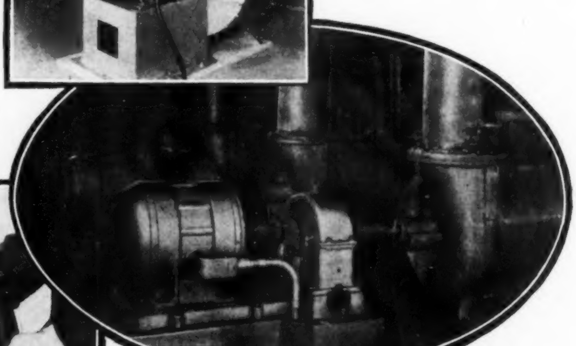
Even in a foundry atmosphere laden with iron dust and fine sand, type ARZ Motors operate without trouble. This motor operates a tumbling barrel for cleaning small iron castings.



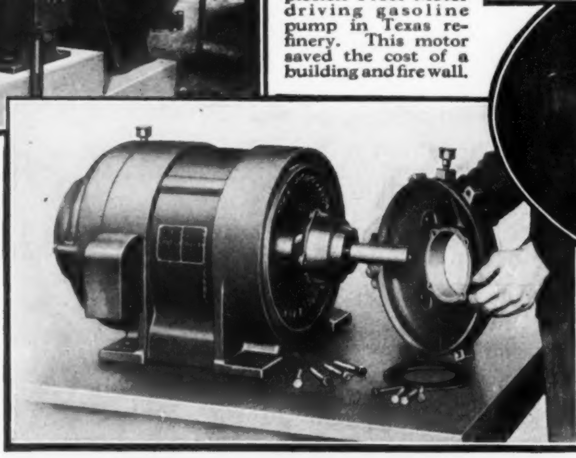
Right — ARZ motor driving fan in a starch mill where fine dust is always present and enclosed motors are necessary for safety of operation.



Left—Type ARZZ Explosion Proof Motor driving gasoline pump in Texas refinery. This motor saved the cost of a building and fire wall.



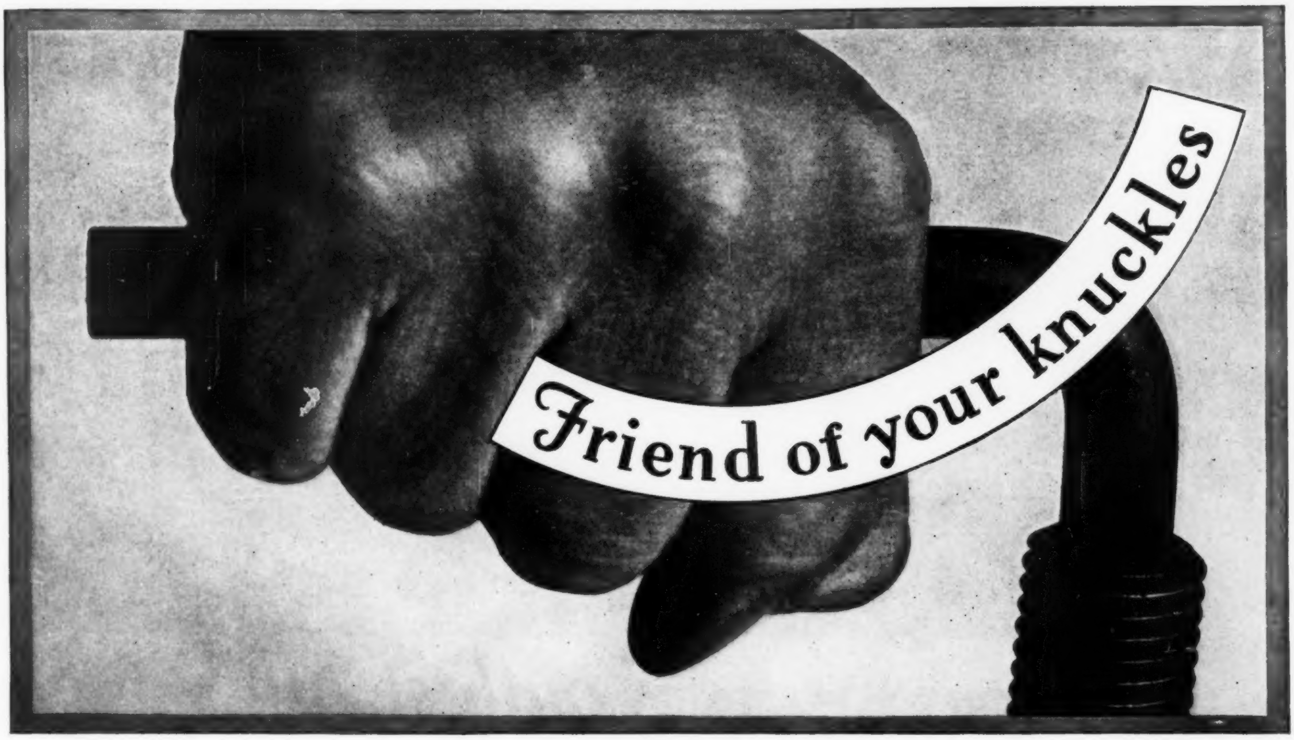
ARZ Motors driving rotary stock screens in a southern paper mill. This mill uses 15,000 h.p. of Allis-Chalmers motors, many of them enclosed as protection against gases, acids and water.



Allis-Chalmers Enclosed Fan - Cooled Motors are as readily accessible as those of the open type.

ALLIS-CHALMERS

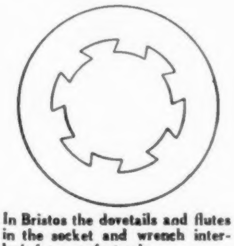
Allis-Chalmers Manufacturing Company, Milwaukee



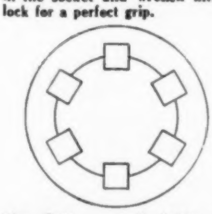
Set 'em up fast----and tight----no fear of slipping!

For fast assembling or for constant adjustment of machinery, no screws like Bristos. The flutes of the wrench *key* into the flutes of the socket. You can't slip and skin your hands as long as the wrench is in place. Neither can you flare or split the socket, for the strain is *keyed in toward the center* instead of toward the outside.

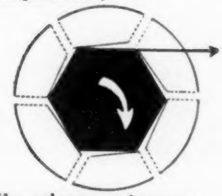
With this almost *integral* grip on the screw, Bristos can be set up quicker and tighter than any set screws you have ever used. This applies to all Bristo Cap and Set Screws, from the big inch and a half size on down to the smallest, no bigger than a match head!



In Bristos the dovetails and flutes in the socket and wrench interlock for a perfect grip.



The Bristo wrench holds the screw as positively as tho it were designed for keys.



Hex and square sockets wear out quickly from pressure on the walls of the socket.

For operation requiring continuous setting and resetting of drills, chucks, cutting tools, etc., try replacing your present screws with Bristos; the saving will soon show on your time records.

For fast, fussy assembling, Bristos are also a big economy; and the trim, inviting look they impart to a product actually increases sales.

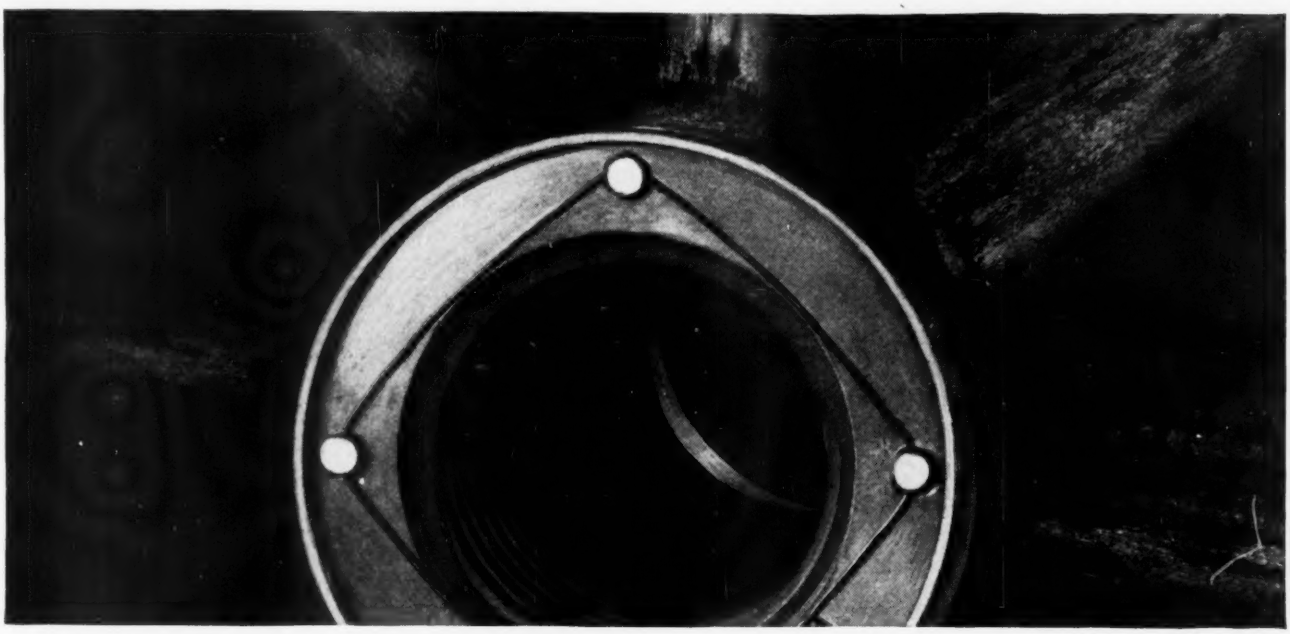
Let us send you sample Bristos for test. Just tell us what sizes you want and how many. No charge; glad to do it.

Bristo Screws may be had with either regular or Dardelet threads.

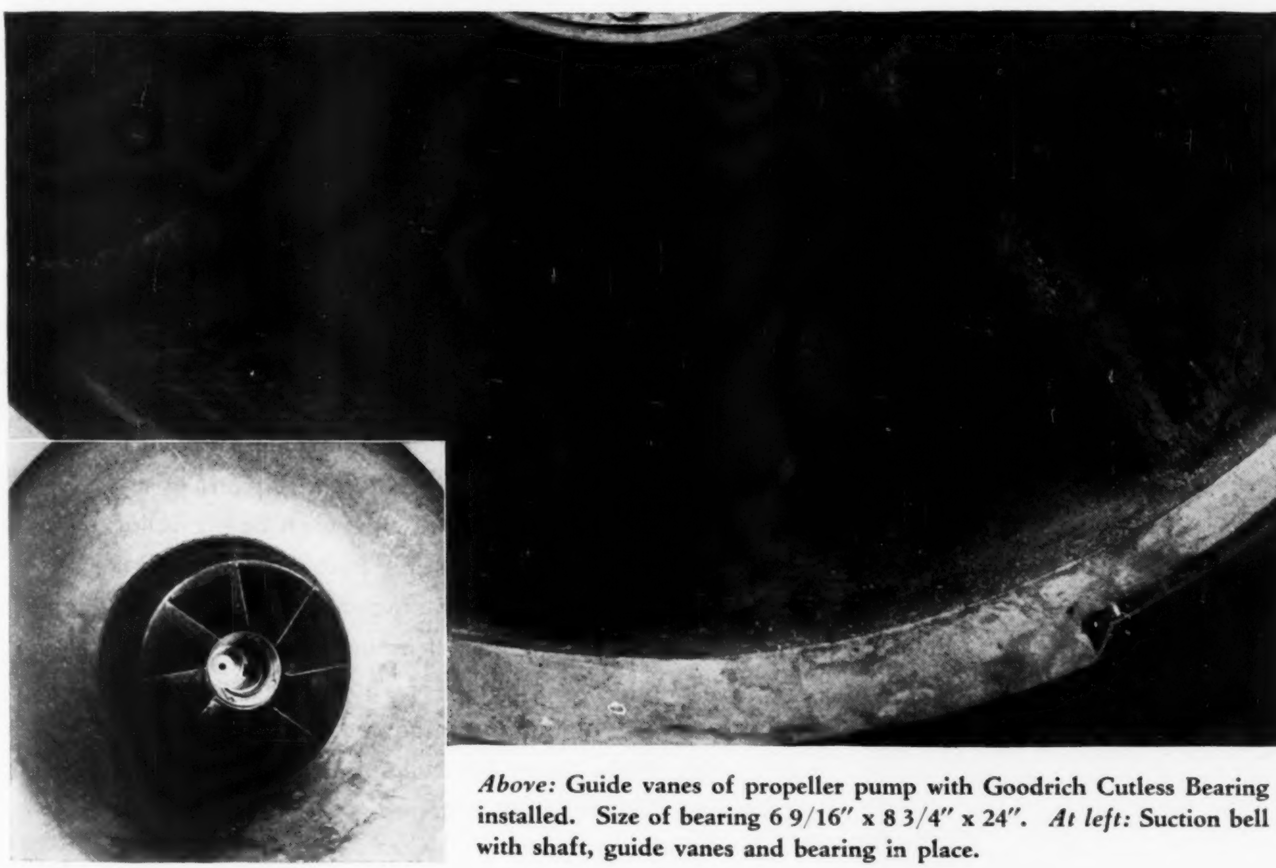
better set screws ....better products

Bristo ..SAFETY SET.. SOCKET HEAD CAP Screws

MANUFACTURED BY THE BRISTOL COMPANY, WATERBURY, CONNECTICUT



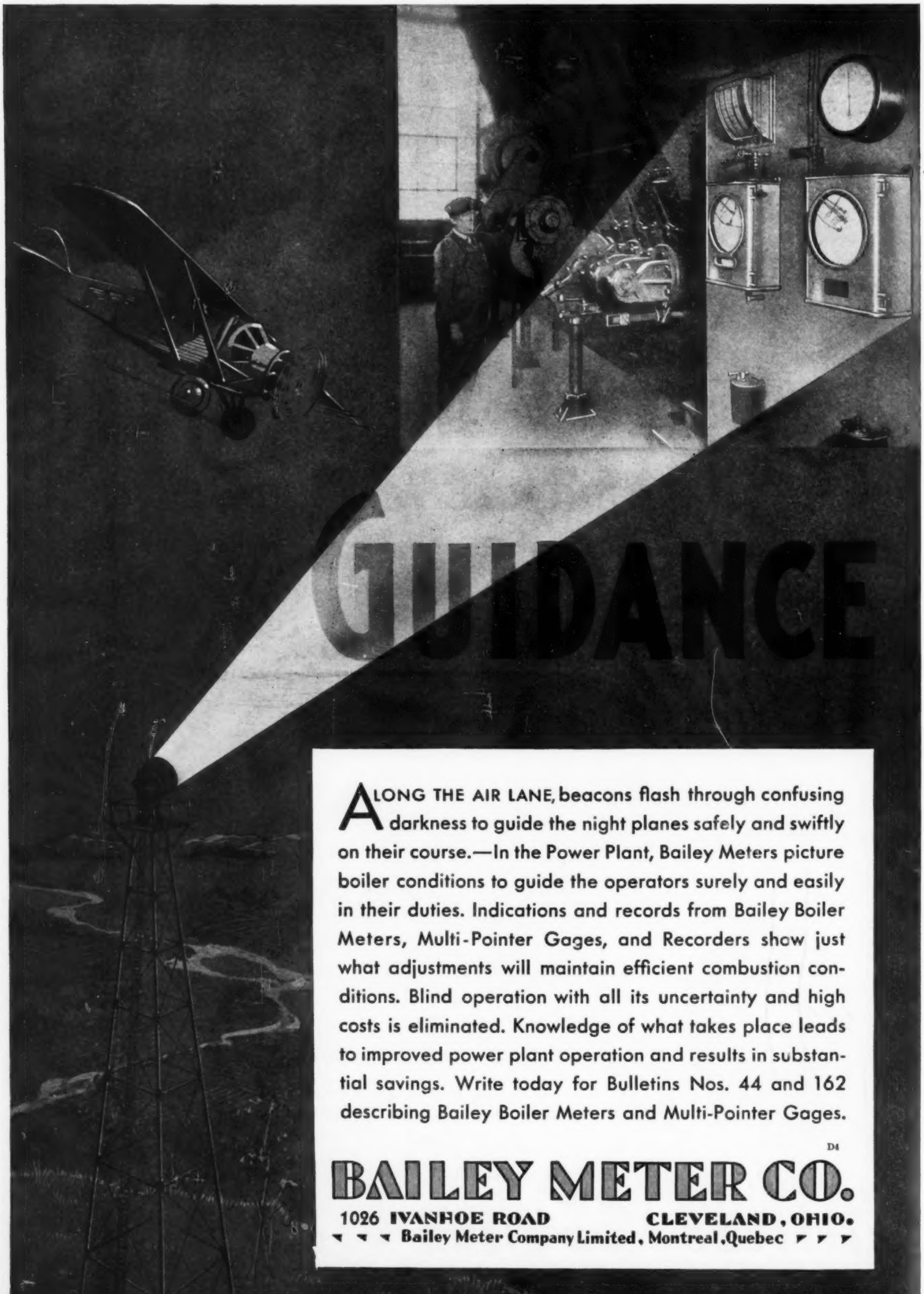
often by as much as ten to one . . . .



Above: **Guide vanes of propeller pump with Goodrich Cutless Bearing installed. Size of bearing 6 9/16″ x 8 3/4″ x 24″.** ***At left:*** **Suction bell with shaft, guide vanes and bearing in place.**

Cutless **Bearings**

Another B. F. Goodrich *Product*



ALONG THE AIR LANE, beacons flash through confusing darkness to guide the night planes safely and swiftly on their course.—In the Power Plant, Bailey Meters picture boiler conditions to guide the operators surely and easily in their duties. Indications and records from Bailey Boiler Meters, Multi-Pointer Gages, and Recorders show just what adjustments will maintain efficient combustion conditions. Blind operation with all its uncertainty and high costs is eliminated. Knowledge of what takes place leads to improved power plant operation and results in substantial savings. Write today for Bulletins Nos. 44 and 162 describing Bailey Boiler Meters and Multi-Pointer Gages.

D4

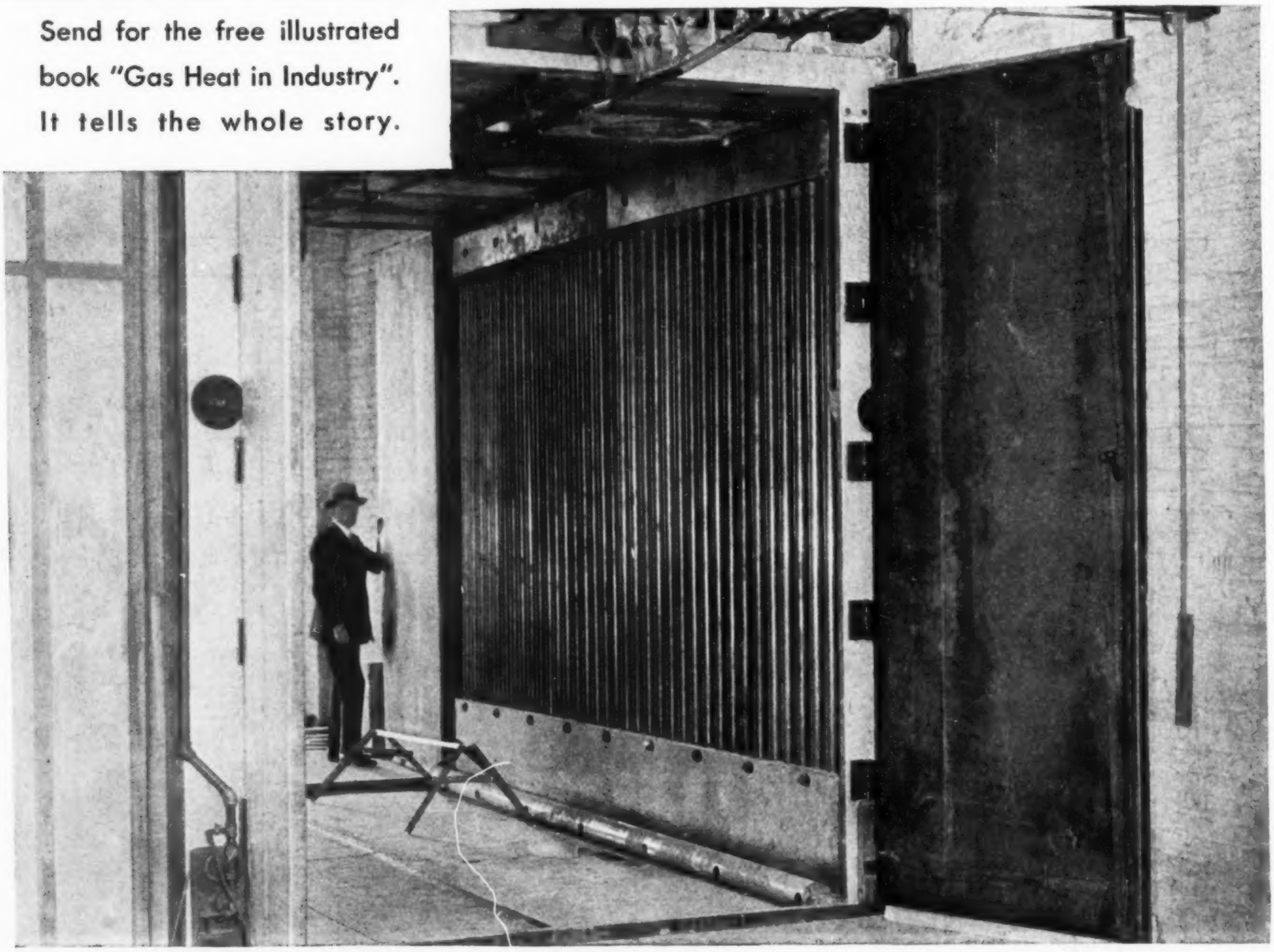
BAILEY METER CO.

1026 IVANHOE ROAD CLEVELAND, OHIO.

Bailey Meter Company Limited, Montreal, Quebec

Japanning with GAS

Send for the free illustrated book "Gas Heat in Industry". It tells the whole story.



GAS heat is well-nigh universal in japanning operations. It meets every requirement — gas heat is easily controlled; uniform temperatures are maintained without effort; the fuel problem is entirely eliminated. Wherever heat is needed, gas will best supply it.

AMERICAN *Gas* ASSOCIATION

420 Lexington Avenue, New York

IMPORTANT . . .

F-M Fig. 5530 Ball Bearing Centrifugal Pump mounted on base with F-M Ball Bearing Motor. Pump may be purchased separately or as a unit with motor. Sizes from 1 to 8 inches.

TO PUMP USERS

A remarkable line of side-suction pumps for belt drive or direct-connection

The Fairbanks-Morse Fig. 5520 and Fig. 5530 Ball Bearing Centrifugal Pumps are the most remarkable side-suction pumps ever developed. Here is a line of low priced, highly efficient pumps built of the finest materials and incorporating many unique features of design. These pumps offer more value per dollar than any heretofore presented to the trade.

Compared detail for detail with any other side-suction pumps, the F-M Fig. 5520 and Fig. 5530 lines stand preeminent in the field of hydraulic design. They are of sturdy construction especially designed for general service and heavy duty. Sizes from one to eight inches with capacities from 25 to 2200 gallons per minute against heads up to 120 ft.

The world-wide distribution and service facilities of Fairbanks-Morse are extremely important to users of F-M pumps. No matter where these pumps may be installed, the services of the organization stand back of them. Where motor-driven pumps are required, the purchaser is assured that with F-M Ball Bearing Motors the units will operate at high overall efficiency with freedom from mechanical troubles. Centralized responsibility is a real protection to the pump user.

FAIRBANKS, MORSE & CO.
900 S. Wabash Ave., Chicago
32 branches at your service throughout the United States

Check these Features!

*

Efficiencies as high as many double-suction pumps

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Unusual mechanical refinements including ball bearings

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Maximum dependability with lowest maintenance costs

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Accessibility with simplicity of assembly

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Moderate in price because of volume production

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Write for Bulletin No. 5020 covering this remarkable line of closed impeller ball bearing pumps

FAIRBANKS-MORSE

pumps & motors

POWER, PUMPING AND WEIGHING EQUIPMENT

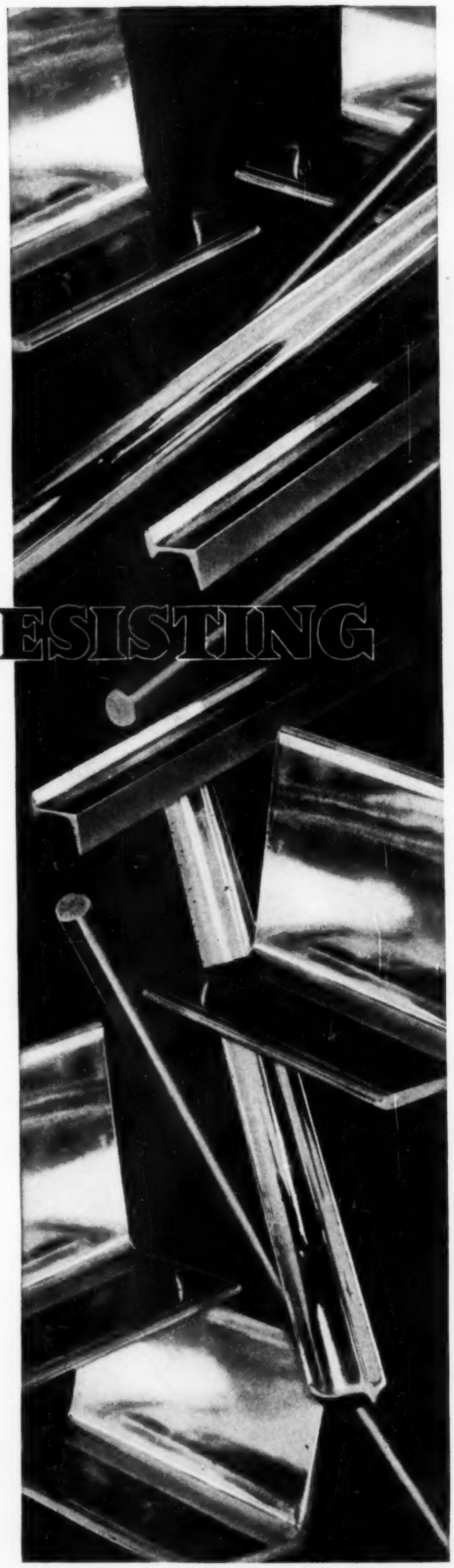
To Modernize

YOUR
PRODUCTS
FOR 1932

Use

USS

STAINLESS AND HEAT RESISTING STEELS



From this group of new alloys you may select the steel most ideally suited to your needs.

Chromium Alloy Steels
(Magnetic)

USS 12 & 12Z
Corrosion resistant steels for machined parts, forgings, and special applications.

USS 17
A corrosion resistant steel for general requirements.

USS 27
A corrosion resistant and heat resistant steel used primarily for high temperature service.

Chromium-Nickel Alloy Steels
(Non-magnetic)

USS 18-8
A variant of USS 18-8 for specific applications.

USS 18-12
Another corrosion resistant steel for a very wide range of uses.

USS 25-12
An outstanding development in heat resistant alloys.

Our representatives will assist you in the selection of the particular alloy best suited to meet the necessary service and manufacturing requirements.

USS Chromium-Nickel Alloy Steels are produced under licenses of the Chemical Foundation, Inc., New York, and Fried. Krupp A. G. of Germany

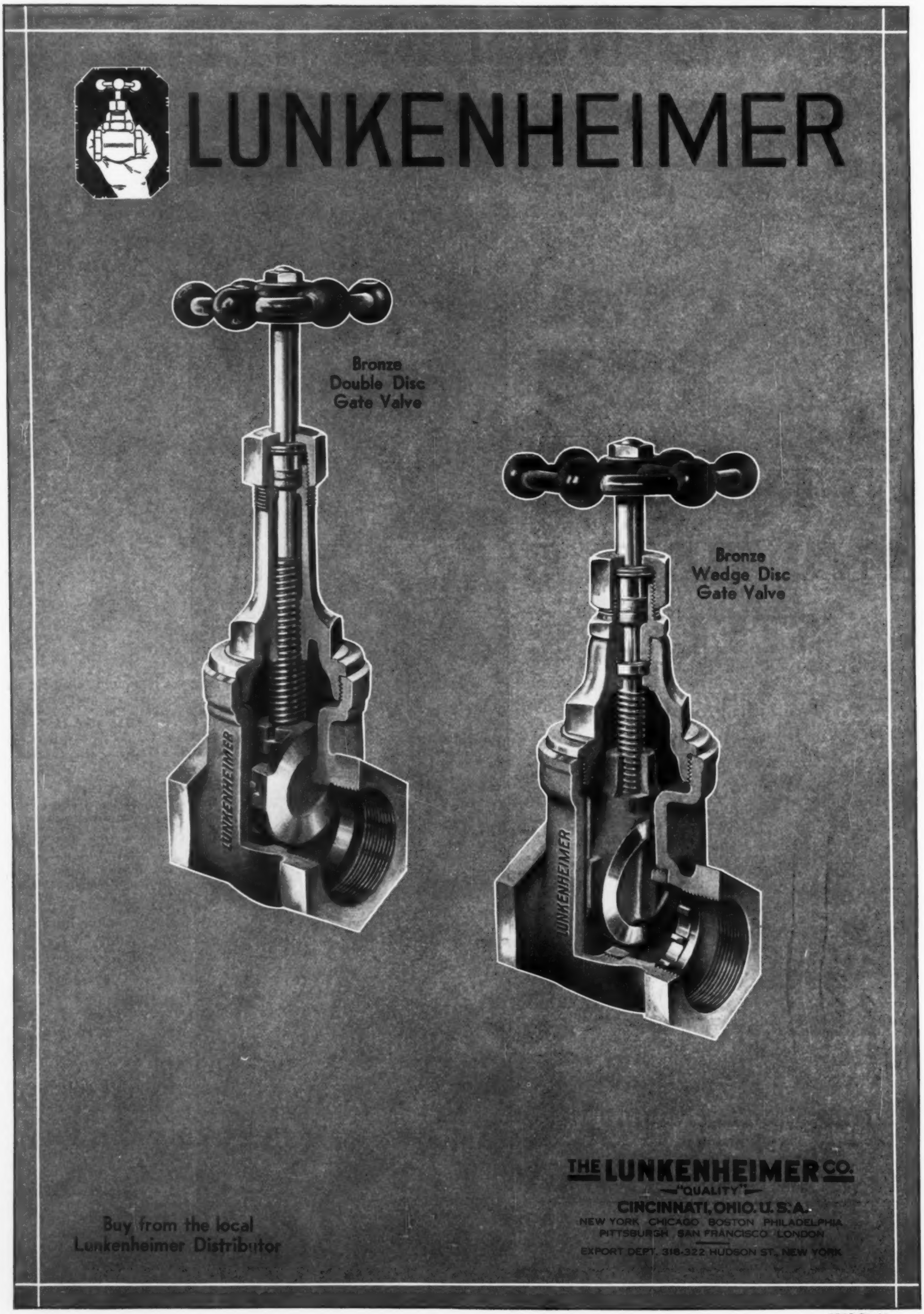
USS STEEL

Illinois Steel Company
Chicago

CARNEGIE STEEL COMPANY
PITTSBURGH

SUBSIDIARIES OF UNITED STATES STEEL CORPORATION

BARS • PLATES • SHAPES • SPECIAL SECTIONS • SEMI-FINISHED PRODUCTS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EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

SHAKEPROOF

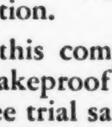
When you use Shakeproof Lock Washers you are giving your product extra protection that is not possible with any other type of washer. This patented locking method defies vibration and only applied force can loosen a nut or screw that is locked by Shakeproof.

The patented twisted teeth bite into both the nut and work surface and as vibration increases they bite in deeper. This powerful force is multiplied many times as each tooth forms a separate lock. The one-piece construction makes this modern washer spreadproof and tangleproof, too. And, finally, Shakeproof engineers are ready to show you how to solve any locking problem without charge or obligation.

Take advantage of this complete locking service now. Test Shakeproof on your own production line—free trial samples will be gladly furnished—mail the coupon today!

U. S. Patents:
1,419,564
1,604,122
1,697,954
1,782,387
Other patents pending.
Foreign patents.

SHAKEPROOF
Lock Washer Company
(Division of Illinois Tool Works)
2511 N. Keeler Ave. Chicago, Ill.



"It's the Twisted Teeth that LOCK"

Type 12. *Internal For S. A. E. and Standard Machine Screws*

Type 11. *External For Standard Bolts and Nuts*

Type 15. *Countersunk For all Countersunk Screws*

Type 20 *Locking Terminals For Radio and Electrical Work*

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New York City, Philadelphia, Boston, Pittsburgh, Schenectady, Cleveland, Detroit, Toledo, Cincinnati, Birmingham, Ala., Dallas, Texas, Milwaukee, Los Angeles, Seattle, San Francisco, Toronto, Ontario, Canada

COUPON

Gentlemen: We want to test your Shakeproof Lock Washers. Kindly send us samples as indicated.

Type .... Size ....

Type .... Size ....

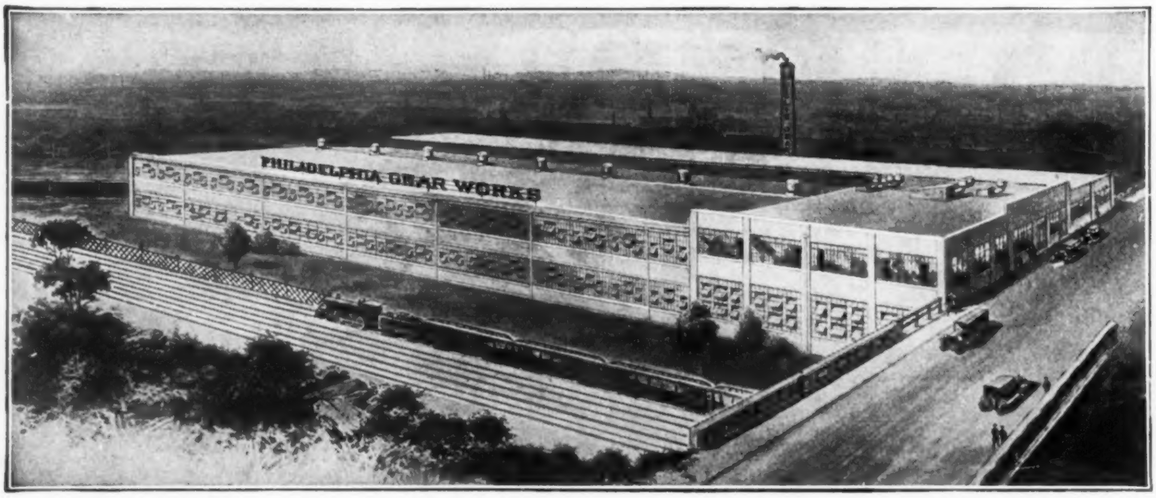
Firm Name ....

Address ....

City .... *State* ....

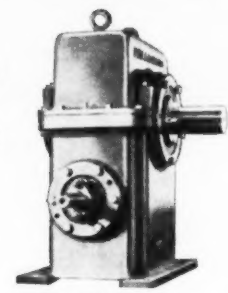
By .... *Title* ....

If it's Gears or Speed Reducers



Spiral Bevel Gears.

—this Modern Plant, plus nearly 50 years Experience is at your Service, day-in and day-out



Philadelphia Worm Gear Reducer with Rolled Steel Housing.

During our long experience, we've made gears of most every size, type and material,—and for practically every conceivable purpose.

When Speed Reducers became a recognized factor for industrial drive requirements, we utilized our vast store of experience and accumulated knowledge to design and place upon the market,—not one type of Speed Reducer,—but a COMPLETE LINE OF GEAR DRIVEN REDUCERS (Worm, Herringbone, Spur, Spiral-Bevel, etc.), thus enabling the manufacturer to have all of his Speed Reduction Problems solved by "one firm,"—and to place the burden of supplying JUST THE RIGHT REDUCER for each individual drive requirement, with this one firm.

PHILADELPHIA POWER SAVING PRODUCTS

Gears—**Spur, Worm, Herringbone, Internal, Bevel, Miter, Intermittent, Spiral, Helical, Continuous Tooth Herringbone, and Spiral Bevel Gears.—*Non-Metallic Pinions*—Fabroil, Textolite, Rawhide.—*Speed Reducer Units*—All types, all ratios, for all drive conditions.—*V-Belt Drives*—A complete line. *Miscellaneous*—Whitney Silent and Roller Chains, Sprockets, Flexible Couplings, Universal Joints, Racks, Ratchets and Pawls.**

Today, there are over 10,000 users of Philadelphia Speed Reducers,....and the list is increasing daily.

We suggest that you write for literature regarding any (or all) of the PHILADELPHIA POWER SAVING PRODUCTS listed opposite. No obligation incurred.

"Confidence is usually the forerunner of repeat orders."

Phillie Gear

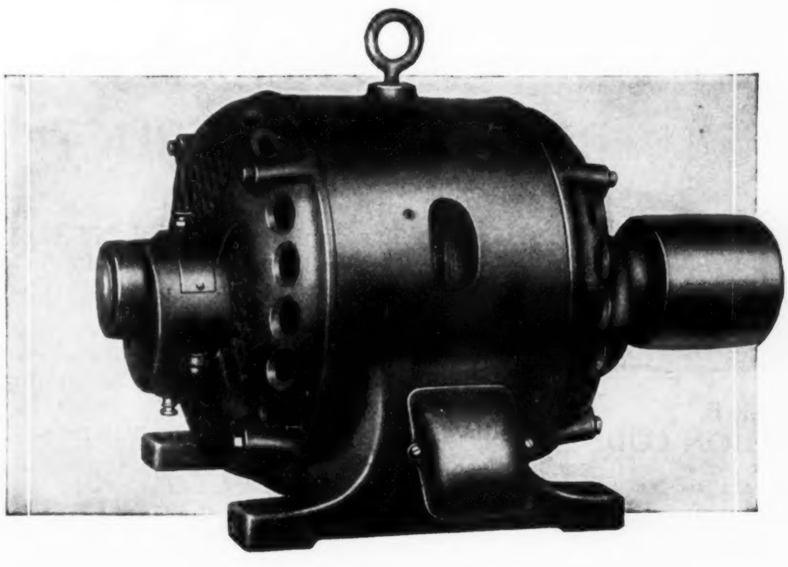
NOTE: If desired, Philadelphia Speed Reducers may now be had with ROLLED STEEL HOUSINGS (which are Shock-proof and Accident-proof.) Also, the famous "Philweld," built-up, Welded Steel Gears may be had in these Reducers, at slight additional cost.

PHILADELPHIA PHILLIE GEAR GEAR WORKS

Industrial Gears and Speed Reducers
Branch Sales and Engineering Offices:

Erie Avenue and "G" Street, Philadelphia
NEW YORK: 12 E. 41st St.—PITTSBURGH: Farmers Bank Bldg.

THEY KEEP A-RUNNING



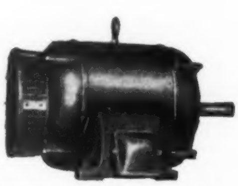
10 Horse Power Century Type SCH Low Starting Current... High Torque Double Squirrel Cage Induction 3 Phase Motor.

HIGH TORQUE— MORE ECONOMICAL

On general purpose jobs, it is often possible to use a lower-rated Century Type SCH Double Squirrel Cage Motor in place of a higher-rated standard Single Squirrel Cage Motor—because the static torque of the Double Squirrel Cage type is substantially higher than that of a standard normal torque squirrel cage motor of the same rating.

Another economy provided for by the Type SCH motor results from its drawing less starting current than the corresponding size normal torque single squirrel cage motor . . . No special current-limiting starting equipment is necessary for 30 horse power and smaller sizes, because their starting currents are within NELA requirements. Any approved across-the-line switch or starter may be used for starting.

Built in standard sizes from 2 to 100 horse power.



Totally-Enclosed Fan-Cooled Motor. Built in standard sizes from 1¼ to 150 horse power.

CENTURY ELECTRIC COMPANY

1806 PINE STREET • • • ST. LOUIS, MO.

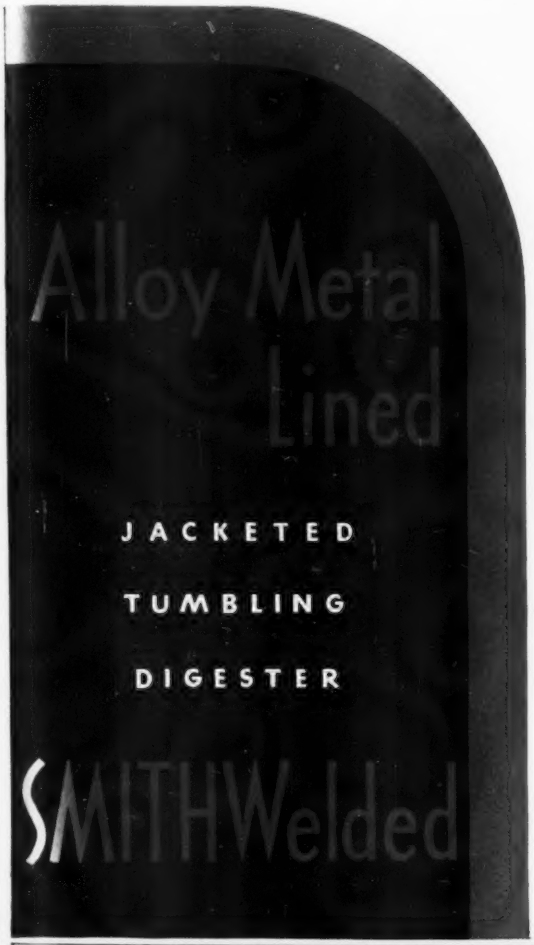
40 U. S. and Canadian Stock Points and More Than 75 Outside Thereof

SINGLE PHASE, THREE PHASE, AND DIRECT CURRENT MOTORS

Century MOTORS

MOTOR GENERATOR SETS, ROTARY CONVERTERS, FANS AND VENTILATORS

FOR MORE THAN 27 YEARS AT ST. LOUIS



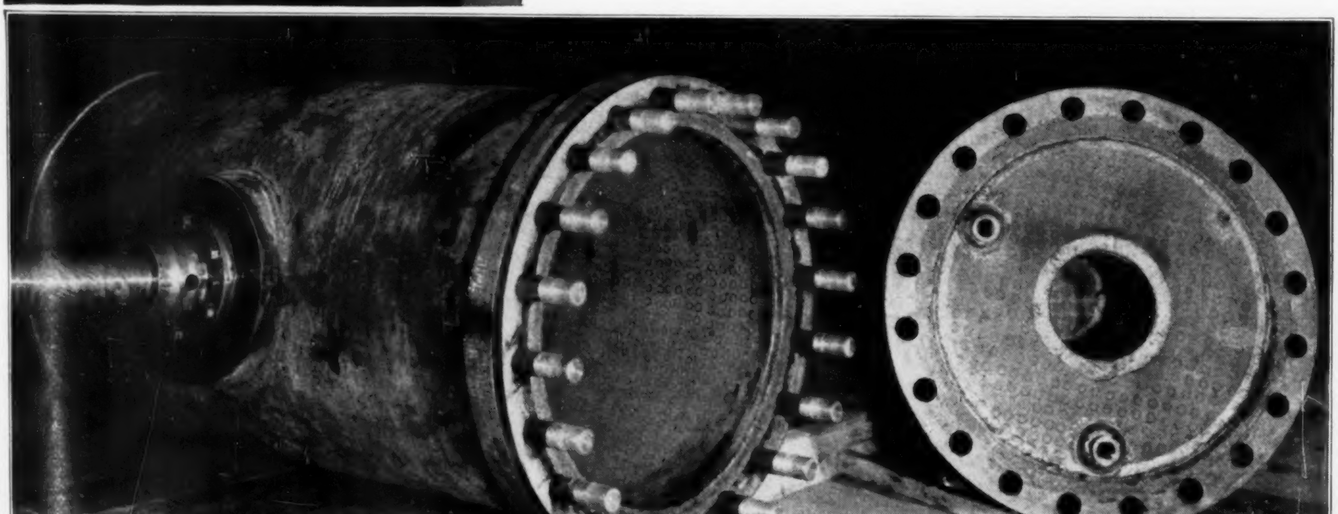
This little Digester, about 6 feet long, is one of several developed and built by this Company for the leading paper pulp laboratories.

Its construction is unique as compared with the brick lined digester in that it can be tumbled and externally heated. These novel features are made possible by SMITH*Lining* with alloy metal.

The metallic lining offers possibilities of utilizing the *same* digester for *different* processes, and can be duplicated in large commercial size vessels.

A. O. SMITH CORPORATION

General Offices: Milwaukee, Wisconsin · PRESSURE VESSEL DIVISION



The SMITH*Lined*-SMITH*Welded Vessel shown at extreme left fits into the vessel next to it, forming the Jacketed Tumbling Digester shown on this page.*

MITH*LINED*

WITH its monthly distribution of nearly 22,500 copies, MECHANICAL ENGINEERING contacts all the important buying influences in industry. It reaches the men who know the product and its technical worth.

Of the mechanical engineers who receive MECHANICAL ENGINEERING over 9,000 are full members of The American Society of Mechanical Engineers—men who must have spent at least ten years in active professional practice and five in responsible charge of important work to reach this standing. The buying power of this class and their importance to industry stand out in much bolder relief when we consider that the billions of dollars spent annually in the building field are controlled by about 7,500 licensed architects.

In addition to the full members of the A.S.M.E., there are over 4,000 associate members, engineers who have been in active professional practice for at least six years; 600 associates, executives of industrial concerns who are qualified to cooperate with engineers in the advancement of professional knowledge; and about 5,500 junior members engaged in subordinate engineering work. Professional information and association motivate the members of the Society, whose standards, as is well known, are very high.

This contact through MECHANICAL ENGINEERING reaches owners, plant and operating engineers, chief engineers, purchasing engineers, designing engineers, consulting engineers, etc., who constitute the buying power of industry. These are the men, whose training, knowledge and judgment determine and specify what is bought.

The occupational and industrial connections of the 22,000 men who comprise the MECHANICAL ENGINEERING audience are given in a new circulation statement. Send for your copy—use coupon below.

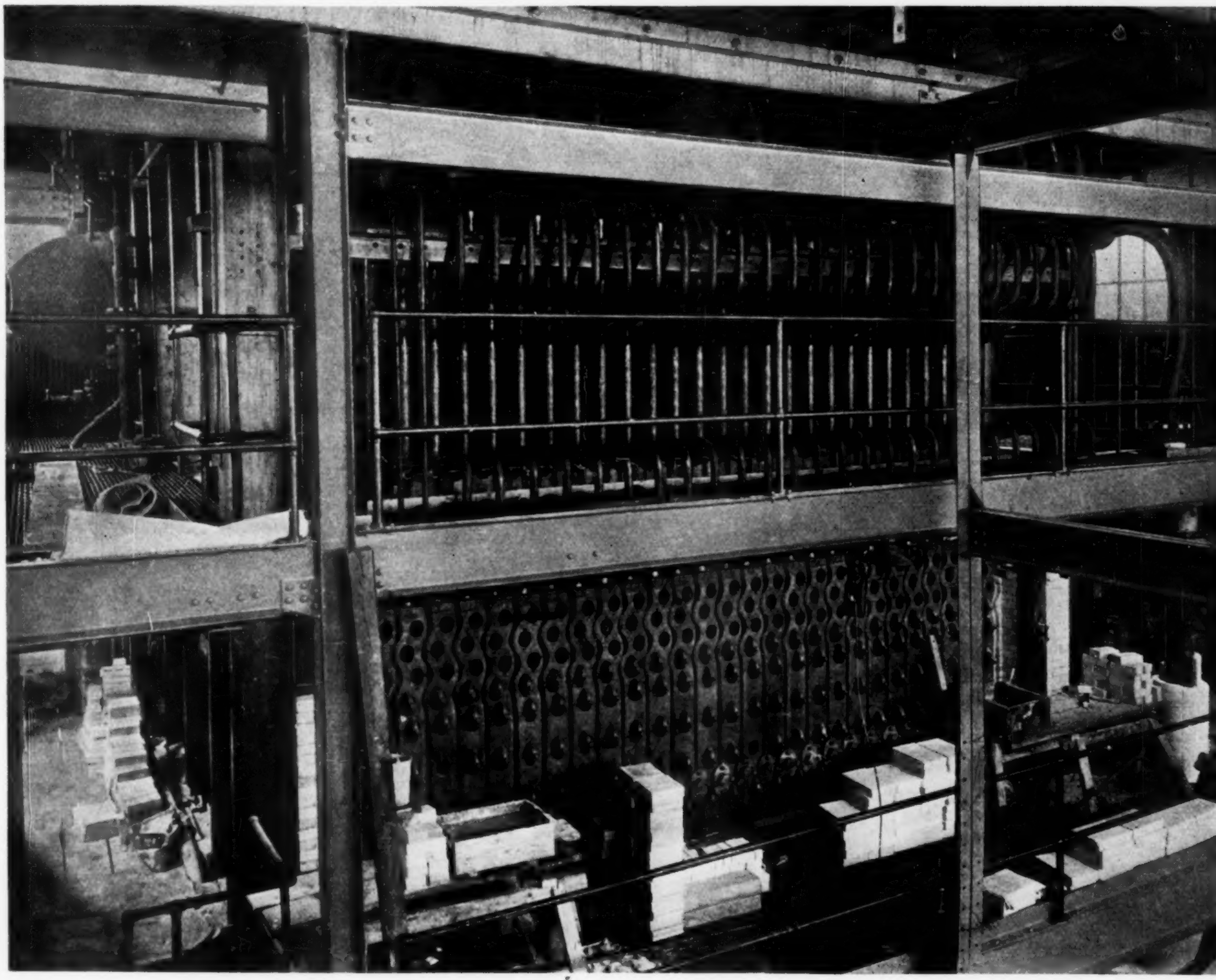
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,
29 West 39th Street, NEW YORK, N. Y.

Please send me copy of latest MECHANICAL ENGINEERING circulation statement.

Name..

Company..

Address..



Modern Steam Generators

The forged steel, sectional header steam generator shown during erection, is now operating under the highest working pressure of any American central station.

The installation also includes superheater, economizer and air preheater by Foster Wheeler. The capacity of the unit is in excess of 215,000 lb. of steam per hr. at 1500 lb. pressure and 810 deg. F. final temperature.

Steam generating equipment, from single pulverizers to large, high pressure steam generators for any requirement, are furnished by Foster Wheeler.

Existing boilers are brought up to modern standards of effectiveness through competent reconditioning.

FW

FOSTER WHEELER CORPORATION
165 Broadway, New York N. Y.

Foreign Associates
- Foster Wheeler Limited; London, England.
- Société Anonyme Foster Wheeler; Paris, France.
- Foster Wheeler Limited; Toronto-Montreal, Canada

Branches in Principal Cities

FOSTER WHEELER


DEFY DUST AND GRIT
DE LAVAL
DE LAV
Slow-moving machinery, such as crushers, screens, conveyors, dryers, pulverizers, kilns, coolers, etc., is most economically driven by standard speed motors through high-grade
De Laval Worm Gears
They possess great durability and reliability and are compact, safe, efficient and fool-proof, the only attention required being occasional renewal of the oil.
The cost of motor maintenance is also greatly reduced, as the gear neither imposes side load on the motor bearings nor sets up chatter or vibration.
Made for ratios up to 100 to 1 in one step, or 8000 to 1 in two steps, and for right or left or vertical shaft drive.
De Laval Steam Turbine Co., Trenton, N. J.

ONLY ONE WAY

to make this kind of welding wire

No "short cuts" can be made in producing a welding wire such as Roebling—a wire of superlative and absolutely unvarying quality. Nothing short of the most painstaking manufacturing methods will do.

The process of making this wire is special throughout and the standards governing every operation are most exacting. Even the steel used for Roebling Welding Wire is special —made from special, selected melting stock and produced by Roebling in special, small open-hearth furnaces.

As a result, Roebling is not the "cheapest" welding wire—but it *is* the most *economical* for work requiring strong, dependable welds.

Investigate the absolutely unvarying quality of Roebling Welding Wire—the fine, strong, tough welds made with it —the economy it assures. Our nearest office will gladly provide full information and samples for testing purposes. Made in both gas and electric types.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N. J.

Wire · Wire Rope · Copper and Insulated Wires and Cables · Flat Wire · Wire Cloth and Wire Netting

New York, Boston, Chicago, Philadelphia, Atlanta, Cleveland, San Francisco, Los Angeles, Seattle, Portland, Ore. *Export Dept., New York*

ROEBLING WELDING WIRE

Advertising Forms
- of -
MECHANICAL ENGINEERING
close on the sixth of the month preceding date of issue.

Space reservations, copy and cuts for advertisements to appear in the January issue should reach us not later than December sixth.

Get this Booklet before you buy Heating Equipment

Hundreds of executives have asked for information on Buffalo Gas Unit Heaters—the units that provide CLEAN, ECONOMICAL HEAT—be sure that YOU have all the facts about MODERN Gas Heating before you buy any kind of heating equipment.

A line on your letterhead will bring a copy of the booklet.

Buffalo Forge Company
148 Mortimer St., Buffalo, New York
In Canada:
Canadian Blower & Forge Co., Ltd.
Kitchener, Ontario

"Buffalo" Gas Unit Heaters

Floor and Suspended Type

HORIZONTAL RETURN TUBULAR BOILERS

These boilers are constructed of high grade materials in full accordance with A.S.M.E. Code.

Regularly manufactured in units up to 250 h.p.; and for steam pressure of 200 lbs. per square inch.

Standard settings can be provided with stationary or shaking grates, and when desired, standard steel casings can be provided for these settings. Liberal proportions of heating surface, steam space and grate area.

Send for our latest bulletins and catalogs

R. D. Cole Mfg. Co. Newnan, Georgia

November, 1931 MECHANICAL ENGINEERING Vol. 53, No. 11
CARD INDEX

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

29 West 39th St. New York, N. Y.

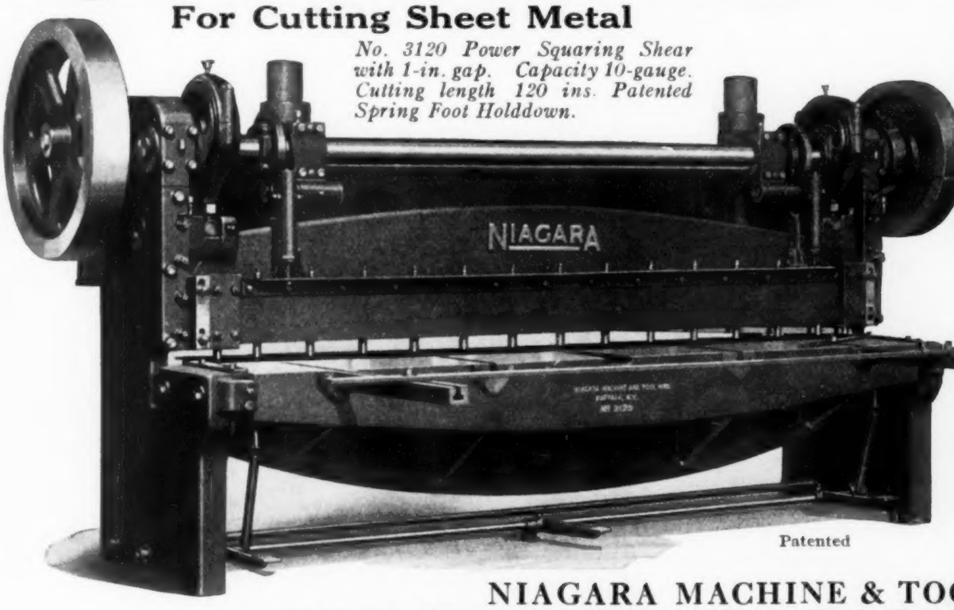
Local Sections are established and conduct professional civic and social activities in the following 70 centers

Akron
Anthracite—Lehigh Valley
Atlanta
Baltimore
Birmingham
Boston
Bridgeport
Buffalo
Central Pennsylvania
Charlotte
Chattanooga
Chicago
Cincinnati
Cleveland
Colorado
Columbus
Dayton
Detroit
Erie
Florida
Green Mountain
Greenville
Hartford
Houston
Indianapolis
Inland Empire
Kansas City
Knoxville
Los Angeles
Louisville
Memphis
Meriden
Metropolitan
Mid Continent
Milwaukee
Minneapolis
Nebraska
New Britain
New Haven
New Orleans
North Texas
Ontario
Oregon
Peninsula
Philadelphia
Pittsburgh
Plainfield
Providence
Raleigh
Rochester
Rock River Valley
St. Louis
St. Paul
San Francisco
Savannah
Schenectady
Susquehanna
Syracuse
Toledo
Tri-Cities
Utah
Utica
Virginia
Washington, D. C.
Waterbury
West Virginia
Western Massachusetts
Western Washington
Worchester
Youngstown

Reports of the activities of these Sections appear currently in the A.S.M.E. News

NIAGARA SQUARING SHEARS

For Cutting Sheet Metal



No. 3120 Power Squaring Shear with 1-in. gap. Capacity 10-gauge. Cutting length 120 ins. Patented Spring Foot Holddown.

Patented

√ Check Their Superior Features

STUDY the thorough, well-developed design of Niagara Squaring Shears that results in perfect operation and strength to handle the load.

Notice that the correct material is used for every part, determined by scientific tests and 50 years' shear-building experience. Check Niagara's superior workmanship in all details, especially moving and bearing parts such as hobbed gears, positive clutch, accurately fitting bearings.

The Niagara line is complete. Cutting lengths up to 16 feet, capacities from light tin up to ¾ inch soft steel plate.

Write for Bulletins

No. 71—Up to 14 Gauge
No. 72—Up to ¼ in.
No. 73—Up to ¾ in.

NIAGARA MACHINE & TOOL WORKS

Manufacturers of Presses, Shears, Machines and Tools for Working Sheet Metal

637-697 Northland Ave. Buffalo, N. Y.

NEW YORK CITY, 50 Church St. PHILADELPHIA, Elverson Bldg. PITTSBURGH, Park Bldg. DETROIT, General Motors Bldg.

Boiler level readings at a distance

with the S & K Water Level Televisor

Electric contacts on boiler drum control illuminated indicator installed anywhere in plant where readings are desired.

No liquids in indicator. Level shown by colored lights.

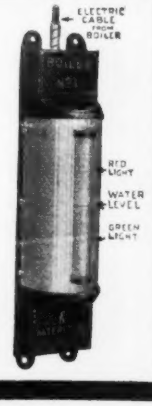
For low, medium and high pressure boilers

Complete details in Bulletin 15-A

1166 Thompson St., Philadelphia

SCHUTTE KOERTING

SEE OUR DATA IN A.S.M.E. Mechanical Catalog 1931-32 EDITION

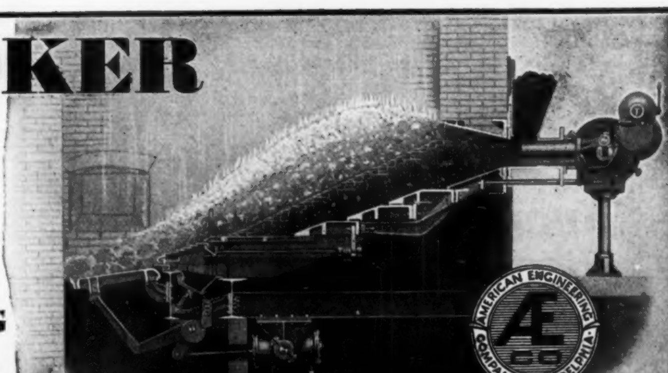


TAYLOR STOKER

Economical, efficient. Burns coal as it comes from the mine. Obtains maximum capacity from boilers.

AMERICAN ENGINEERING Company

2414 Aramingo Ave., Philadelphia



AMERICAN ENGINEERING COMPANY PHILADELPHIA

SPECIALIZED CONSULTING SERVICE

in

ALL BRANCHES of the ENGINEERING FIELD

The cards of Consulting Engineers appearing on pages 76, 77 and 78 of this issue serve as an index to professional service in the mechanical field. Specialized service may be obtained through this section on such subjects as

Accounting
Advertising
Appraising
Building Equipment
Combustion
Construction
Copyrights
Cost Systems
Designing
Electrical
Foundries
Furnaces
Gas Plants
Heating and Ventilating
Hydraulic Work
Industrial Plants
Inspection
Invention Development
Investigations
Machinery Designing
Management
Manufacturing Methods
Marine
Material Handling
Oil Refineries
Organization
Paper and Pulp Mills
Patent Law
Petroleum
Plant Construction
Power Plants
Power Transmission
Production
Publicity
Purchasing
Refrigeration
Research
Silk Mills
Special Machinery
Statistics
Sugar
Taxes
Testing
Textile Machinery
Textile Mills
Textiles
Time Study
Tool Designing
Trade Marks
Valuation
Vibration
Water Purification
Water Supply
Work Routing

KEELER
WATER TUBE BOILERS

Types { BENT TUBE 3 OR 4 DRUMS / LONGITUDINAL DRUM / CROSS DRUM

DOUBLE DUTY (Improved fire tube type)

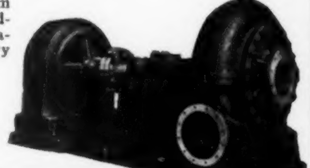
HORIZONTAL RETURN TUBULAR

1864 **E. KEELER CO.** 1931
Williamsport, Pa.

MORRIS
CENTRIFUGAL PUMPS

FOR hydraulic dredging, filling, sand and gravel production, hydraulic conveying, reclaiming river coal, etc. Types and sizes for the largest or smallest operations, and belt, motor, steam or gasoline engine drive. Standard or special design for any capacity, and suction and delivery heads.

Write for Bulletin



Morris Machine Works
Baldwinsville, N. Y.

J&L
JONES & LAMSON

Hartness Flat Turret Lathe
Fry Automatic Lathe
Hartness Automatic Die
Hartness Comparator
Flanders Ground Tap
Hartometer Screw Thread Gage

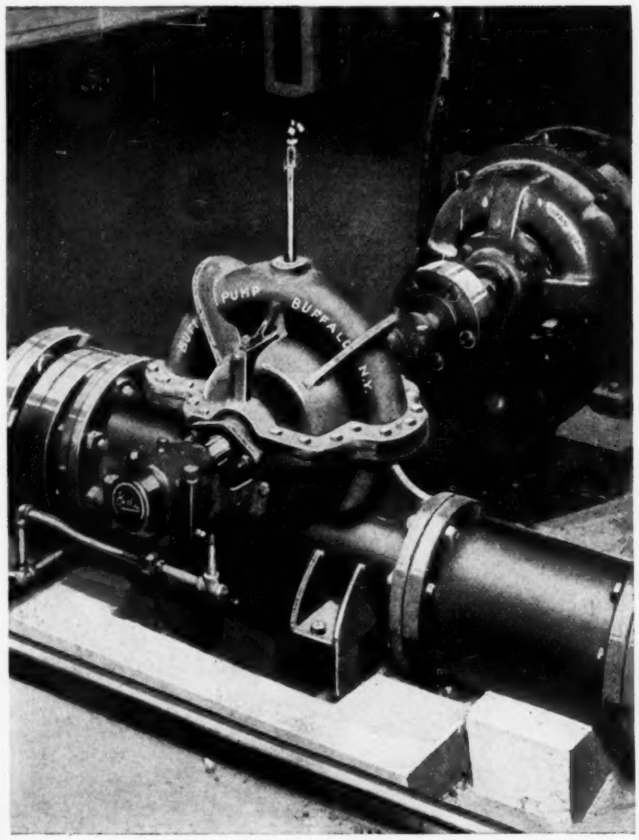
JONES & LAMSON MACHINE CO.
SPRINGFIELD, VERMONT

INFILCO **Water Purification Equipment**

Water Softeners and Filters—Of Every Type and Size
Taste—Odor—Chlorine—Color—Iron Removal Plants
Wet and Dry Chemical Feeders—Proportioning Devices
Rate of Flow Controllers—Gauges—Venturi Meters

INTERNATIONAL FILTER CO.
59 EAST VAN BUREN STREET, CHICAGO

INTERNATIONAL



For Every Industrial Use

Of prime importance to the buyer of pumps is the pump manufacturer's knowledge of the service for which the pumps are to be used. In this respect, we are fortunate. "Buffalo" Double Suction Pumps are in use in practically every branch of Industry, in many cases handling difficult jobs more satisfactorily than ever before.

With our knowledge of specialized application and the customer's knowledge of his own needs, we are able to recommend the pump best fitted for that particular job—often at a saving in first cost—always at a saving in operating costs over many other types of equipment.

Sales engineering offices in all principal cities are ready to serve you.

BUFFALO PUMPS, Inc.
148 Mortimer St. Buffalo, N. Y.
In Canada: Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo" Single Stage Double Suction Pumps

Faultless Service is yours for the asking

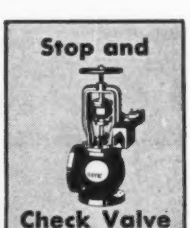
The common faults of many float valves—leaking or sticking—will never trouble you if your valve is a Davis. Its perfected design—simple and effective—insures *faultless service.*

Unlike other Float Valves, the Davis has a single seat with renewable composition disc, and has no leather cup packing. It closes tight and it will not stick. It is a pilot controlled valve operated by pressure.

Your open tank will never overflow if you use a Davis Float Valve on the make-up line. When this valve closes the flow is entirely stopped. It can be used to control pump operation directly by pressure or indirectly through a pump governor.

Have your requisition read DAVIS FLOAT VALVE and enjoy its efficient dependable service.

DAVIS REGULATOR COMPANY
2545 S. Washtenaw Avenue Chicago, Illinois



DAVIS VALVE SPECIALTIES

ME 12 Gray

TABER PUMPS

PRICED RIGHT

You get more than you expect of a standard centrifugal pump when you order a Taber. Changeable Impellers is one of the extra values.

Your request for quotation will show you our price is right. What are your needs? Write us, requesting comprehensive Bulletin G-631.

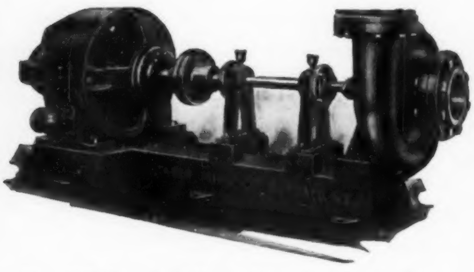


Fig. 603-G. Impeller is kept in true position. Stuffing Box is four shaft diameters deep. An extra value pump.

TABER PUMP Co.
292 Elm St., BUFFALO, N. Y. Est. 1859

1907

1931

For

Twenty-five Years

—the money from the sale of Christmas Seals has promoted:

—the establishment of sanatoriums for treating tuberculosis

—the finding of tuberculosis in time to effect a cure

—health inspection of school children

—the teaching of habits that help to insure good health

—the bringing of rest, good food, sunshine, fresh air, medical attention to sick children

Help Fight Tuberculosis

BUY CHRISTMAS SEALS

THE NATIONAL, STATE AND LOCAL TUBERCULOSIS ASSOCIATIONS OF THE UNITED STATES

Professional Engineering Service

CLASSIFIED INDEX

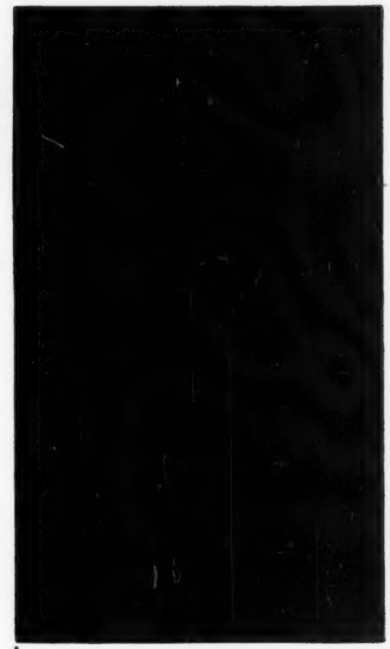
Card announcements of the Engineers listed below will be found alphabetically arranged on the following pages

Cards Continued on Next Page

EQUIPMENT ESSENTIALS

DESIGN WORKMANSHIP MATERIAL

Vol. II No. 12



Four points to remember in choosing centrifugal pump shafts

By J. G. Rearick, Chief Engineer,
Warren Steam Pump Company, Inc., Warren, Mass.

Reliable and successful operation of pumping equipment depends to a very large extent on the selection of suitable materials, particularly for centrifugal pump shafts and rods for reciprocating pumps. The material for these parts must possess the following characteristics:

1. Its physical properties must be such as to insure continuously safe transmission of the required work without undue bending or twisting.
2. It must retain permanency of shape and finish.
3. It should possess non-corrosive properties.
4. It should permit finishing to a high polish to minimize friction.

A metal meeting the characteristics outlined above helps to insure smooth operation, reduce mechanical losses through reduction in friction, facilitates the renewal of parts fitted to the shafts and rods, and reduces maintenance expense.

This is another in a series of editorials in which leaders stress the importance of Material, the 3rd Essential, in modern power plant equipment.

WARREN *recognizes* Monel *Metal as the* 3rd Essential *in Centrifugal* Pump Shafts . . . .

Warren single stage centrifugal pump with Monel Metal shaft for bronze impeller, as manufactured by Warren Steam Pump Company, Inc., Warren, Mass.

Years of experience in building centrifugal pumps for the highly specialized requirements of the power plant field have convinced the Warren Steam Pump Company, Inc., that Monel Metal possesses the best available group of properties for pump rods. This manufacturer has found that Monel Metal's combination of rust-immunity, corrosion-resistance, toughness and rigidity, coupled with its mirror-smooth surface, insures dependable, low-cost pump performance over long periods of severe service. Consequently, Warren always recommends Monel Metal pump rods for its pump equipment installations.

Ask us to send you further information about Monel Metal pump rods and other Monel Metal power plant equipment.

Monel Metal is a registered trade mark applied to a technically controlled nickel-copper alloy of high nickel content. Monel Metal is mined, smelted, refined, rolled and marketed solely by International Nickel.

MONEL METAL

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.

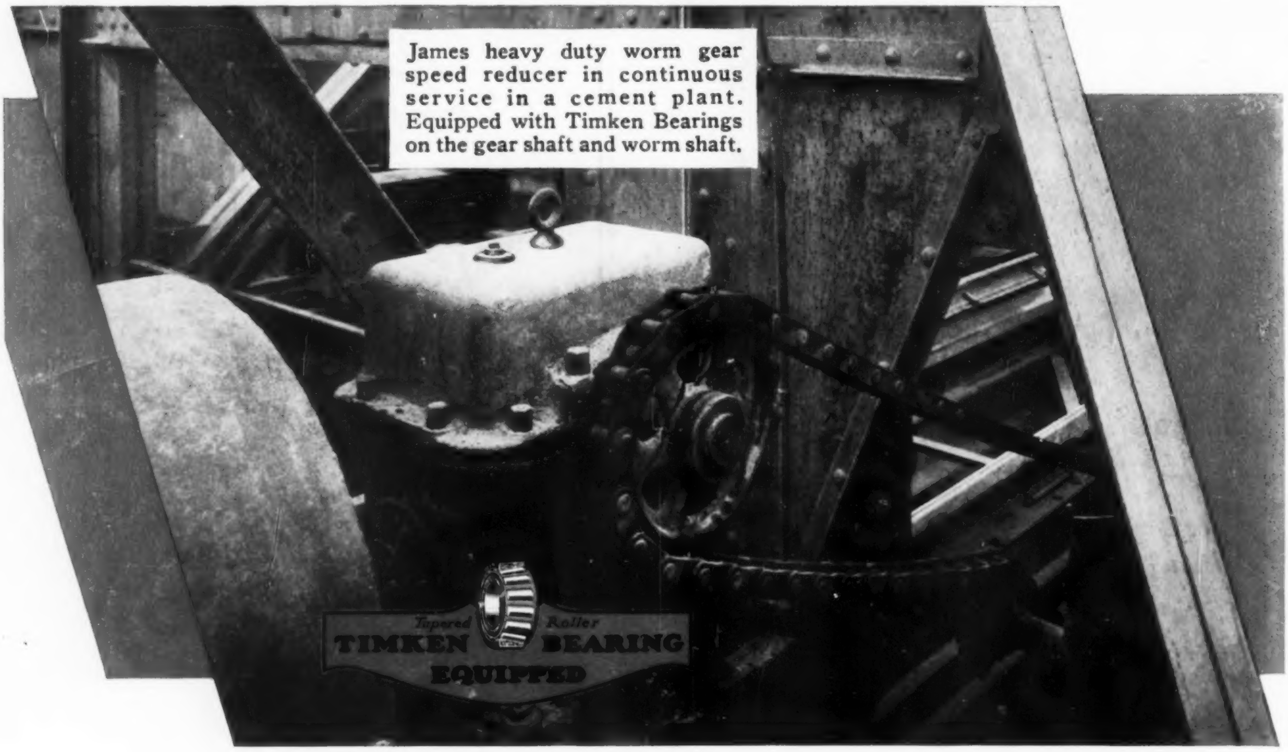
Alphabetical List of Advertisers

Card Announcements in PROFESSIONAL ENGINEERING SERVICE SECTION will be found on pages 76, 77 and 78

Advertising Forms of MECHANICAL ENGINEERING close on the sixth of the month preceding date of issue

Space reservations, copy and cuts for advertisements to appear in the Jan. issue should reach us not later than Dec. sixth.

*Catalog data of firms marked * appear in the Mechanical Catalog, 1931-32 Edition*


James heavy duty worm gear speed reducer in continuous service in a cement plant. Equipped with Timken Bearings on the gear shaft and worm shaft.
Tapered Roller
TIMKEN BEARING
EQUIPPED